THE

GEOLOGICAL MAGAZINE

NEW SERIES. DECADE VI. VOL. I.

No. XII.—DECEMBER, 1914.

ORIGINAL ARTICLES.

I.—The Lateritic Deposits of Mozambique.

By Arthur Holmes, A.R.C.S., D.I.C., F.G.S., F.R.G.S.

(PLATE XXXVII.)

In his *Last Journals*, referring to the formations of Portuguese Nyasaland west of the Lugenda River, Livingstone writes: "The elevated plains among these mountain masses show great patches of ferruginous conglomerate, which, when broken, looks like yellow hæmatite with madrepore holes in it." He also notes that the same formation is responsible for the prevailing reddish tint assumed by the soil. In Mozambique, the province of Portuguese East Africa south of Nyasaland, lateritic deposits of the kind described by Livingstone are very abundant. In view of the wide interest which the superficial deposits known as laterite have aroused among geologists during recent years, no excuse seems necessary for placing on record a few notes dealing with their modes of occurrence and associations in Mozambique.[1] The country was explored during the year 1911, Mr. D. A. Wray, Mr. E. J. Wayland, and myself accompanying the expedition as geologists. My former colleagues have kindly placed their notes on the superficial deposits of Mozambique at my disposal, and I wish here to express my indebtedness to them for the help thus afforded.

Following the nomenclature of Dr. L. L. Fermor,[2] the lateritic deposits of Mozambique may be classified as laterite, quartzose laterite, and lateritic sand or earth. Cases of the occurrence of lateritoid, formed by the metasomatic replacement of the underlying rocks at their outcrops, are doubtful, and, in any case, are of little importance compared with the widespread occurrences of other types, the chief of which is quartzose laterite. The latter forms exceedingly hard, slag-like masses, brown and varnished at the surface, but paler in colour where unexposed to the atmosphere, as, for example, on freshly broken surfaces. The rock is frequently concretionary and cavernous, the holes being occupied by a powdery ferruginous earth, or by angular and subangular fragments of quartz, which with fragments of other

[1] For a short account of the geology and geography of Mozambique see respectively Holmes & Wray, Geol. Mag., 1912, p. 416, and Holmes & Wray, *Geog. Journ.*, xlii, p. 143, 1913. For a map of Mozambique, prepared from the results of the expedition of which the present writer was a member, see *Geog. Journ.*, xlii, p. 112, 1913.

[2] Geol. Mag., 1911, p. 514.

minerals and rocks, less commonly found, sometimes makes up a considerable proportion of the formation. Many of the laterites are richly ferruginous, and comparatively poor in aluminium hydroxides.[1] On the other hand, examples of nearly pure bauxite are known, and between the richly ferruginous and richly aluminous varieties intermediate types occur. Oxides of manganese and titanium are also present, sometimes considerable quantities of the former constituent. Only qualitative analyses of specimens examined in the field and of those brought home have so far been made, so that it is not possible to give more than the above general indication of their composition.

The rocks over which laterite occurs in Mozambique are of various kinds. Mr. Wray records its presence in numerous instances on hornblende gneiss (e.g. north of Namkoko) and on biotite gneiss (e.g. between Mkonta and Ntia). Mr. Wayland found it on different varieties of gneiss and on basalt. The sedimentary belt (Cretaceous and Tertiary) of the coast is free from laterite, which, however, is of frequent occurrence on the basalts of the Tertiary volcanic belt. Although detrital quartz is here still the commonest inclusion, occasionally fragments of agate or of basalt may be found. Indeed, the former distribution of the basaltic flows may to some extent be inferred from the presence of fragments of basalt in laterite where no basalt now exists in situ. On the metamorphic plateau beyond the coastal belt, it is worthy of notice that no ferruginous laterite was ever found on granite. The Mozambique granites are uniformly poor in ferromagnesian minerals, whereas the gneisses, which are very abundant and are the most usual hosts of the laterite, are generally rich in dark bands of hornblende and biotite. On the Mluli River, just north of the Mwipwi Mountains, laterite occurs on a gabbro rich in labradorite and impregnated with pyrite. It occurs on a similar rock on the eastern side of the Lulaua River near its confluence with the Ligonia. Near the Erikola Peaks I found laterite on a hypersthene-plagioclase dyke rock which also contained pyrite. The ubiquitous gneiss of Mozambique is penetrated by numerous pegmatite veins which are frequently rich in magnetite and hæmatite, especially in the western parts of the territory. They are generally parallel to the strike of the banding and foliation of the gneiss, although they may also be transverse, sometimes forming a complicated network. Although the average width of the veins amounts to only a few inches, crystals of iron-ore as large as a walnut are not uncommon. South-west of the Ribawe Mountains the superficial rock debris is rich in hæmatite, a mineral greatly prized by the natives, who collect it for the manufacture of spear-heads and knives. The importance of such iron-bearing rocks in the genesis of ferruginous laterite is obvious.

In some cases the laterite was found to lie on unaltered fresh rock, a conclusion which microscopic investigation has since supported. However, the underlying rocks were always moist and frequently they were soft and disintegrated, limonite having been deposited between the mineral grains. Pits sunk in the lateritic earths showed that these lay on a floor of soft moist gneiss, with large and small

[1] By many geologists some of these deposits would be referred to as lateritic iron-ores.

fragments of iron-stained gneiss in the lower layers of the deposit. The general upward succession appears to be from unaltered gneiss through moist disintegrated gneiss to similar material deeply stained with a ferruginous cement. On this lay the lateritic earths, damp in their lower levels, but dry above, and with a strong concentration of the lateritic constituents at or near the surface.

The laterite shows a striking disposition to lie in well-marked bands, sometimes continuous but generally broken, parallel to the strike of the underlying gneiss, or to the pegmatite veins which penetrate the gneiss. It is found only on the gently undulating plateau and never on the steep slopes or summits of the inselberg peaks and mountain blocks which, as one proceeds westwards from the coast, rise up abruptly in increasing numbers and altitude. The plateau surface itself, which rises from sea-level at the coast to a height of 1,000 feet at Nampula, to nearly 2,000 feet around the Ribawe Mountains, and to about 3,000 feet in the neighbourhood of the Namuli Peaks, is diversified by numerous low ridges traversing the country parallel to the strike of the gneissic foliation, the direction of which lies between N.E. to S.W., and N.N.E. to S.S.W. (Fig. 1). These ridges have a 'dip' slope which usually lies on the west or north-west side, and an 'escarpment' slope, the gradient of

FIG. 1.—Typical Section in Maravi's country, north of the Mitikiti River, illustrating the occurrence of laterite on the escarpment slope of a ridge.

which, however, is only a little steeper than that of the dip slope. The prevailing dip of the foliation and banding, especially in the eastern part of the country, is in a direction away from the sea, so that when the angle of dip is low, the truncated foliation of the gneiss is more plainly visible on the escarpment slope than on the dip slope, wherever an exposure is encountered. The first and simplest feature in the distribution of laterite in Mozambique is that it frequently lies in bands near the crests of the ridges on the escarpment side (Fig. 1). It thus comes in many places to have the appearance of being actually interbedded with the gneiss. Mr. Wray records a good example which he found between the Mrupi Mountains and the Luli River. There he traced an important band, continuous for a mile and a half, between two hard outcropping bands of coarse hornblende gneiss.

Bands of laterite are also commonly found near the sides of small watercourses, the majority of which dry up during several months of the year. Mr. Wayland was impressed with the fact that many of the bands lie on the eastward side of the gullies, and that where laterite is found on both sides the development is greater on the eastward side. My own field maps indicate several such occurrences which are, I think, to be correlated with the predominant direction of dip of the foliation of the gneiss, for in such cases the dip is

generally down towards the streams on the eastward side, and away from them on the westward side (Fig. 2). Instances could also be given (e.g. south of Otetani, by the Monapo River) where the dip is towards the streams from the westward side and where the laterite is restricted to the westward side. In other cases no such correlation is possible, laterite being equally developed on both sides, as for example along the upper course of the Namieta River, which cuts transversely across the gneiss.

In the western part of the territory, where the mountain blocks are more numerous and lofty, where the dip is more frequently at a high angle, and where the streams are less liable to become completely dry during the rainless season, laterite tends to occur in widespread sheets as well as in individual bands. In the sheets themselves, however, a broadly banded structure may often be discerned, strong, hard,

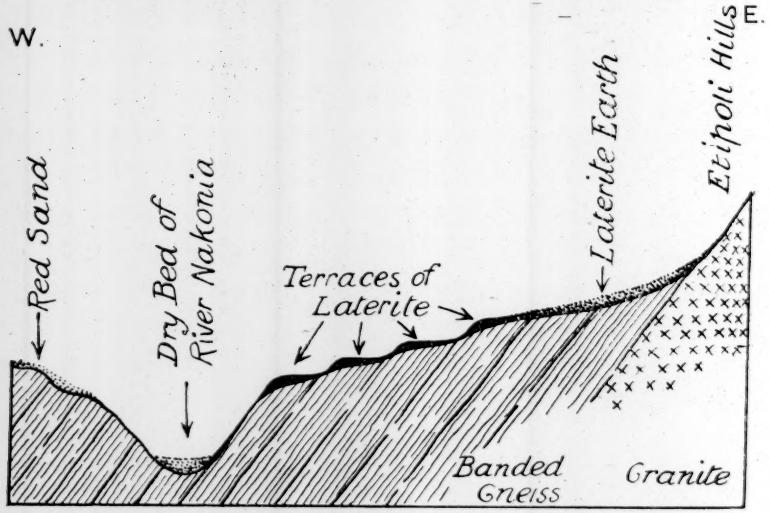


FIG. 2.—Section at the foot of the Etipoli Hills near the Ligonia River, illustrating the occurrence of laterite on the eastern side of a gully.

quartzose laterite alternating with what is little more than a lateritic earth capped with a hardened ferruginous cement. Such sheets are common between the Chica Range and the Ligonia River, in the district south of the Ribawe Mountains, and between the Mluli Mountains and the Luli River. In thickness the lateritic deposits are very irregular, varying within a short distance from a few inches to several feet.

The relation of laterite to vegetation has been the subject of very diverse opinions. In Mozambique it was evident that where the forest and undergrowth were thick no laterite occurred at the surface. In fact, the deposit was almost always associated with areas where the superficial debris was clean and free from organic matter and the so-called 'humus' acids. It has been asserted that the humus acids can decompose silicates, but since the humus acids are themselves

insoluble in water alone, their efficiency in the production of laterite is doubtful.[1] Alkaline solutions readily dissolve the humus acids, and it therefore appears that where dissolved silica is found in association with the latter the alkalis have been the effective solvent of the silica.

Laterite was never observed in the neighbourhood of marshy land or swamps, which appeared always to be comparatively free from ferruginous deposits of any kind.

In view of the evident importance of underground drainage in the genesis of laterite, it may be of interest to describe a cave deposit which was examined by Mr. Wayland and myself. Our first base camp was built at Sawa, on a projecting spur in a deep valley running northwards into the Ribawe Mountains. On each side of the valley the mountains rose up precipitously, and the foliation of the gneiss could be plainly seen dipping away at a gentle angle to the north (Plate XXXVII). On the eastern side the nearly vertical face of the gneiss was eaten away here and there into caves, the entrances to which ran along the 'dip'. Those which we explored widened and narrowed in the most remarkable way, defying explanation. In each case a steady drip of water trickled from the roof and from narrow fissures which penetrated the rock parallel to the foliation, thus demonstrating that a considerable drainage of water percolated northwards down the 'dip' through the apparently impermeable gneiss. The roofs of the caves were lined with a thick highly polished deposit of limonite which also covered the upper parts of the walls, gradually becoming thinner as the floor was reached and giving place to bright pink rhodochrosite and black pyrolusite. Where a true floor was visible it was also covered with these minerals, the manganese oxide and carbonate coating the thicker deposits of limonite. In the largest cave, however, much of the floor was buried under the droppings of bats, and this was encrusted with fine needles of vivianite. We had a hole dug through this material in order to expose the gneiss below, and were astonished to find a considerable thickness of sand, in which, at a depth of about a foot, we found the ashes of a wood fire and fragments of coarse pottery, proving a former human occupation of the cave and suggesting that, at least in part, its excavation may have been due to human agencies. The gneiss itself, when uncovered, was found to be perfectly fresh.

The source of the deposits was not difficult to find, for the hill is penetrated with numerous pegmatite veins rich in magnetite and franklinite. Water, charged with carbon dioxide, would readily leach out iron and manganese as carbonates. On reaching a cave, oxidation and evaporation would cause a precipitation of iron-hydroxide, followed by that of the more stable manganese carbonate, some of which would slowly become oxidized to pyrolusite.

This example has been described in order to demonstrate the percolation of iron-bearing solutions along the fissures and foliation planes of gneiss, a phenomenon which appears to be responsible for much of the laterite of Mozambique. Similar cave deposits have been recorded from Mt. Tugwi, near Nampula. On the western side of

[1] Clarke, *Data of Geochemistry* (U.S.G.S. Bull. 491, p. 98, 1911).

a hill near Nakavala, known as Mhala, a cave has been formed by the breaking away of a large mass of gneiss, clearly due to slipping along a moistened joint plane parallel to the foliation, which here dips steeply towards the west. Here also, three or four hundred feet above the plateau, a slow trickle of water percolated through the hill, but only a very thin coating of limonite had been deposited on the roof, and practically none on the steeply sloping floor. In this case the gneiss was free from impregnations of iron-ore. Near the Portuguese fort at Chinga, a spring of iron-bearing water strongly charged with carbon dioxide rises through the gneiss and forms the source of a stream which flows during the dry season to the dried-up channel of the Namieta. On each side of the stream and around Chinga itself are considerable spreads of laterite and lateritic earths.

It is important to notice that the steep slopes of the inselberg peaks and mountain blocks are always free from deposits of the lateritic constituents. Solutions must certainly exist which on evaporation would give rise to such deposits, but the mountain rains and night dews suffice to carry them down to the debris-covered plateau surface below, where they contribute to the formation of the lateritic earths which so frequently sweep round the base of the hills.

The close association of bands of laterite with watercourses has already been mentioned. It is therefore significant that the lower parts of large river beds (e.g. the Monapo), which in the dry season shrink to a succession of stagnant pools, often contain a considerable number of tiny ferruginous nodules distributed among the gneissic and granitic debris of the river floor. In small tributary streams which dry up completely, nodules which reach the size of a small bean are frequently very plentiful, and in some cases the beds are locally paved with sandy laterite, formed by the cementation of large numbers of the nodules with gravel and sand. One of the best examples occurs in a gully which drains into the Nrassi River from the high peak of Ericola. Here many of the nodules were found to have a nucleus of sand. This district was carefully studied by Mr. Wayland, and independently by myself, and we found that the gully did not pass through any lateritic deposits, so that the nodules were not detrital but were clearly formed *ab initio* in the dried-up bed. Mr. Wray found a lateritic conglomerate on the floor of a dry stream near Ribawe, between the Sawa and Ntumba Valleys, where it rested directly on a coarse gneiss. In the dry streams of the Nrassi district every gradation can be found between tiny nodules of iron-ore and massive nodular conglomerate which often is developed on the up-stream side of large boulders and ridges, owing to the accumulation of large numbers of nodules and their subsequent cementation. In the beds of streams which do not dry up, such as the Sawa, the Bwibwi, and other streams in the mountainous areas, no nodules could be found amongst the gneissic gravel. This clearly proves that the nodules are formed only where there is an alternation of saturation and solution, with evaporation and precipitation, corresponding to the 'wet' and 'dry' seasons respectively. The ground water below the *thalweg* dissolves the lateritic constituents from the underlying rocks, and as the stream dries up some of this water rises to the surface

by capillarity and evaporation. The solutions are strengthened both by adsorption in the interstices of the sand and by contact with a previous precipitation. For this reason a nodule once begun tends to continue growing, for at its surface the concentration of the solutions is strongest and precipitation by oxidation is therefore more favoured than elsewhere. In this connexion it is interesting to notice that the sands and gravels of dry streams are not strongly iron-stained, except where a hard floor of laterite has formed, the iron being almost entirely concentrated in the nodules. The smooth, rounded, and frequently spherical forms of the latter are due to the fact that deposition is most favoured where the radius of curvature is greatest.

Having now demonstrated the existence of waters, bearing in solution the lateritic constituents, and draining along the foliation planes of the gneiss, and having also shown that these constituents are deposited where evaporation and oxidation can occur, it is possible to turn to the laterite proper and attempt an explanation of its formation. Near the eastern banks of streams where the gradient has cut across the foliation of the gneiss, ground water from the *thalweg* is drawn up by capillary attraction and evaporation, and at or near the surface, where the solutions become oxidized, deposition takes place. It is possible that this action is strongest immediately after the wet season, when the laterite itself is soaked, and deposition is most vigorous at the upper surface. In this way the formation gradually grows upwards as a mechanical replacement, incorporating rock debris (generally quartz and sand) which has fallen upon its surface. Later in the dry season, as the level of the ground water sinks, deposition will occur at lower and lower levels, a possibility which is in keeping with the fact that the Mozambique laterite becomes less and less cavernous with depth. On the other hand, the lateritic earths which envelop the base of the mountains are always damp, fed daily by the heavy dews which are precipitated on the steep rocky slopes, and here a thin hard capping of laterite is found only at the surface, the deposition falling off rapidly in depth owing to the prevalence of permanent moisture. The explanation offered above for the formation of laterite on the sides of streams serves equally well for its occurrence on the sides of ridges where the foliation is truncated by the slope of the land, for fissures are more abundant parallel to the foliation than across it and the upward drainage takes place more easily along the foliation than across it.

The simple cases so far considered do not, of course, include all the occurrences of laterite in Mozambique. Bands of laterite are occasionally found running across the strike of the gneissic foliation, and in so far as such cases are rare it is possible that the circumstances attending their formation are also somewhat special. Pegmatite dykes and joints may also be found running transversely to the main structural lines, and it is obvious for these and other reasons that the underground drainage is not solely conditioned by the foliation. If, however, the more general statement be made that the formation of laterite depends on the drainage and evaporation of the ground waters, I believe most of the Mozambique examples would be included.

It has already been stated that ferruginous laterite was not found on granite. The occurrence of aluminous laterite or bauxite on granite has, however, been observed. Mr. Wayland found a reddish iron-stained bauxite on pyrite bearing pegmatite veins running through the gneiss near the Nrassi River due east of Erikola. Later I found similar material over a small granite intrusion which was plainly visible in a gully draining the southern slopes of Erikola to the Nrassi. Mr. Barton, the leader of the expedition of which we were members, found at Nakota, north of the Ligonia River, large pegmatites mineralized with sulphides. Some of these were capped with bauxite, and, equally interesting, the gneiss in the neighbourhood was for a considerable depth metasomatically replaced by silica. This association would appear to be genetic, but as I was ill with fever at the time and camping at Akwari, several miles away, I was unable to study the deposits myself and cannot therefore discuss them further.

It only remains to place on record the occurrence of kaolin as an alteration product of granite. This was found by Mr. Wayland near the Chika Range, and by myself on the side of a deep gully north of the Mwipwi Mountains and west of Arunto. In the latter case the granite is reduced to a china clay rock in all respects similar to that of the Cornish granites. It was well exposed in section, as the Portuguese had made a small quarry in order to pave with the soft china clay a wooden bridge which carried the military road over the gully. Traced to the north and east, the kaolinized granite gradually gives place to fresh unaltered granite as seen where it outcrops. Where the kaolin occurs, however, there was no natural outcrop, for above the rock a thick deposit of black damp soil, rich in organic material, hid it from view. The vegetation on each side of the gully was unusually thick. It is possible that the kaolin may have been derived from felspars by the action of organic acids or of carbonated waters produced by them. Similar cases have previously been described.[1]

There are, then, in Mozambique, precisely similar granites, in some of which the felspars have broken down into kaolin, while in others aluminium hydroxides have been formed, combined silica having been liberated and removed, or redeposited metasomatically. In looking for different conditions to correlate with these two processes, all that can be said is that the formation of kaolin seems to be conditioned by the presence of a heavy growth of vegetation, and that of bauxite by the absence of heavy vegetation and humus, and the presence in the parent rock of sulphides. What chemical significance these contrasts may have, I do not feel at present justified in discussing. Laboratory experiments of a kind not yet attempted are evidently necessary before the central problem of lateritization can be satisfactorily solved. It is possible, however, that the secret processes now in operation for the manufacture of aluminium from felspar might throw an important light on the origin of laterite. In the absence of

[1] Stremme, *Zeit. Prakt. Geol.*, 1908, pp. 122, 443; Wüst, *Zeit. Prakt. Geol.*, 1907, p. 19.

experimental data, the facts given in the present paper may help others to attempt the explanation for which geologists are waiting.

EXPLANATION OF PLATE XXXVII.

East Peak, Sawa Base Camp, Ribawe Mountains, Mozambique, Portuguese East Africa. Lat. 14° 56′ 39″ S.; long. 38° 17′ 10″ E. Height 2,889 feet. The banding of the gneiss and its 'dip' from south to north (right to left) can be seen along the hillside above the hut. The great scars which break up its otherwise smooth surface mark the position of a series of caves which have developed along the direction of dip.

II.—On the supposed case of Tin *in statu nascenti* in the Malay Peninsula.

By W. R. Jones, B.Sc. London, F.G.S., Assistant Geologist F.M.S.

Communicated at the request of the Government Geologist F.M.S.

M. STANISLAS MEUNIER, in a paper entitled "Examen Chimique d'eaux minérales provenant de Malaise. Mineral d'etain de formation actuelle",[1] describes analyses of two waters brought by M. J. Errington De la Croix from Ayer Panas and Cheras, Malay Peninsula, and also of a mineral specimen found in one of the springs. A copy of the original paper is, unfortunately, not available here, but Dr. Bott, in a paper entitled "Thermal Springs of Selangor and Malacca",[2] quotes Meunier as follows:—

"A mineral found in the spring is described, having a specific gravity of 2·1, cavernous and tuberculous structure, whitish grey colour, with small black dendritic patches in it. The composition of this is given as—

	%
Silica	91·8
Water	7·5
Tin oxide	0·5
Iron	0·2
Aluminium	traces
	100·00

"From this the author draws the remarkable conclusion that this substance is a kind of opal similar to geyserite, but containing tin as a peculiar and characteristic constituent.

"He goes on to say that this is the first time that tin has been formed *in statu nascenti*, as it were, viz., in the act of deposition from its mother liquor, and looks upon this as an important contribution to the theory of the formation of tin-ore."

At the suggestion of Mr. Scrivenor, the Government Geologist F.M.S., I visited the above springs with the view of testing Meunier's assertion, and the object of this short paper is to prove that tin has not been found *in statu nascenti* in these or any other springs in Malaya.

[1] Published in J. cx, p. 1085 of the Compt. Rend., and quoted by Dr. Bott.

[2] Dr. W. Bott, F.C.S., F.G.C.S., etc., Journal of the Straits Branch of the Royal Asiatic Society, December, 1891, pp. 43–62.

It is not clear from Dr. Bott's paper whether the mineral specimen analysed by Meunier was obtained from Ayer Panas ('hot water') or from Cheras, and as there are two places named Ayer Panas in Malacca at both of which are hot springs, and as Cheras is north of the State of Malacca and in the State of Selangor, some doubt exists as to the exact locality from which the specimen was obtained. All these springs, however, have been examined recently.

At Ayer Panas, near Jasin in Malacca, there are six hot springs within a circle of about twenty yards diameter, and probably connected together below the surface. The difference in temperatures of these springs is probably due entirely to the different distances from the main spring and to different proportions of surface-water with which they are mixed. The writer visited these springs during dry weather, and this accounts probably for the higher readings he obtained compared with those of Dr. Bott:—

Dr. Bott in August to September, 1890.

No. 1. 45° C. No. 2. 35° C. No. 3. 45° C. No. 4. 52° C. No. 5. 55° C.

W. R. Jones in July, 1914.

Tank A. 56·5° C. Tank B. 52·5° C., 52·3° C.

The springs are in a padi swamp. The smell of sulphuretted hydrogen can be distinguished several yards away from the springs.

At Ayer Panas, near Alor Gajah in Malacca (at the 19th mile on the Tampin road), one spring is enclosed in a bricked well, and the other rises a few feet away.

	Dr. Bott.	*W. R. Jones.*
Water in bricked well . . .	55° C.	56° C.
Water in brook	40° C.	52° C.

The smell of sulphuretted hydrogen is distinct near the springs.

Granite is in situ less than a mile away, and its junction with mica-schist on the Alor Gajah side may be not far from the hot springs. On the Tampin side the junction was seen near the 21¾ mile.

At Cheras, about 3¾ miles from Kajang in Selangor, the hot spring rises in low ground covered with high grass, and in wet weather it is swampy. The highest temperature obtained was 46·25° C. There is a distinct smell of sulphuretted hydrogen in the neighbourhood. Granite is exposed on the road between Cheras and Dusun Tua, and further work would probably show that granite outcrops not far from the Cheras hot springs.

There are hot springs at Dusun Tua in Selangor, and these issue from a fracture in tourmaline-granite. In a bricked well a temperature of 72·1° C. was registered. The smell of sulphuretted hydrogen can be distinguished a hundred yards from the spring on certain days, and the water tastes of this gas.

On a Chinese rubber estate near Ulu Yam in Ulu Selangor a hot spring rises within a few yards of the junction of the granite and mica-schist. The granite contains a little cassiterite in this neighbourhood. Sulphuretted hydrogen is present in the water.

Below are given Dr. Bott's analyses of these waters, and it will be noticed that he has allocated the acids, as was generally done in those days, to their presumed bases.

ANALYSES OF WATERS.

	Ayer Panas, Jasin, Malacca. Dr. Bott.	Ayer Panas, Alor Gajah, Malacca. Dr. Bott.	Dusun Tua. Dr. Bott.	Great Geyser of Iceland.[1]
Total solids in water (in grains per gallon)	18·40	1·7	15·4	
Hardness	2·50	2·5	2·3	
Chlorine	0·70	0·5	0·25	
Free ammonia (per million parts)	0·05	0·04	0·04	
Albuminoid ammonia (per million parts)	0·05	0·05	0·03	
Constituents dissolved in 10,000 parts of water.				
Calcium carbonate	0·160	0·200	0·1357	
Calcium sulphate	0·180	0·140	0·11400	
Magnesium sulphate	0·015	0·025	0·01200	0·042
Sodium sulphate	0·190	0·150	0·09900	1·07
Potassium sulphate	0·085	0·950	0·06300	0·475
Sodium carbonate	0·450	0·550	0·0800	1·939
Ammonium carbonate	0·00018	0·00015	0·00053	0·083
Sodium chloride	0·095	0·075	0·05100	2·521
Potassium chloride	0·006	0·005	0·00400	
Lithium chloride		trace	trace	
Sodium sulphide	0·200	0·019	0·00900	0·088
Hydrogen sulphide	0·025	0·020	0·03200	
Carbon acid	0·585	0·480	0·92000	0·557
Nitrogen	0·085	0·075	0·07000	
Silica	0·780	0·590	0·61200	5·097
Organic matter	0·250	0·295	0·04031	
Boric acid	—	—	trace	
Potassium iodide	—	—	—	

No trace of tin was found by Dr. Bott, and recent tests carried out by Mr. C. Salter, Chemist to the Geological Department F.M.S., and the writer have failed to give any traces of tin in solution in these waters. It is to be noted that Meunier is not quoted by Dr. Bott as having found tin in solution in the water, but seems to have based his conclusion that tin was *in statu nascenti* solely on the result of the analysis of the mineral specimen which he described as "a kind of opal similar to geyserite . . ." The deposition of tin oxide from water containing sulphuretted hydrogen is, as Dr. Bott points out, a chemical impossibility.

Careful search in the neighbourhood of these hot springs has failed to prove the presence of any such mineral deposit, and when it is considered that these hot waters contain less than one part in 10,000 of silica, that they contain other metals in solution, and that they commingle with surface-waters near their outlets, it would be astonishing to find them depositing a mineral having 91·8 per cent of silica and no other metal besides tin-ore and iron. The composition

[1] *Ann. Chem. Pharm.*, 1847, p. 49, quoted by Geikie in *Textbook of Geology*, vol. i, p. 317.

of a geyser water which forms a siliceous deposit is given for comparison.

The soft vegetable and other matter which had accumulated at the bottom of some of the disused wells was collected and tested for tin. No trace of tin was found in a single case.

It is a significant fact that the specimen examined by Meunier gives an analysis strikingly different from all other 'opal deposits' and 'geyserites'. Below three analyses are given for comparison with that of Meunier, and it will be noticed that whereas Meunier obtained traces only of alumina, the other analyses show weighable amounts of alumina and other metals. Out of a long list of analyses of such minerals nothing approaching that given by Meunier has been seen.

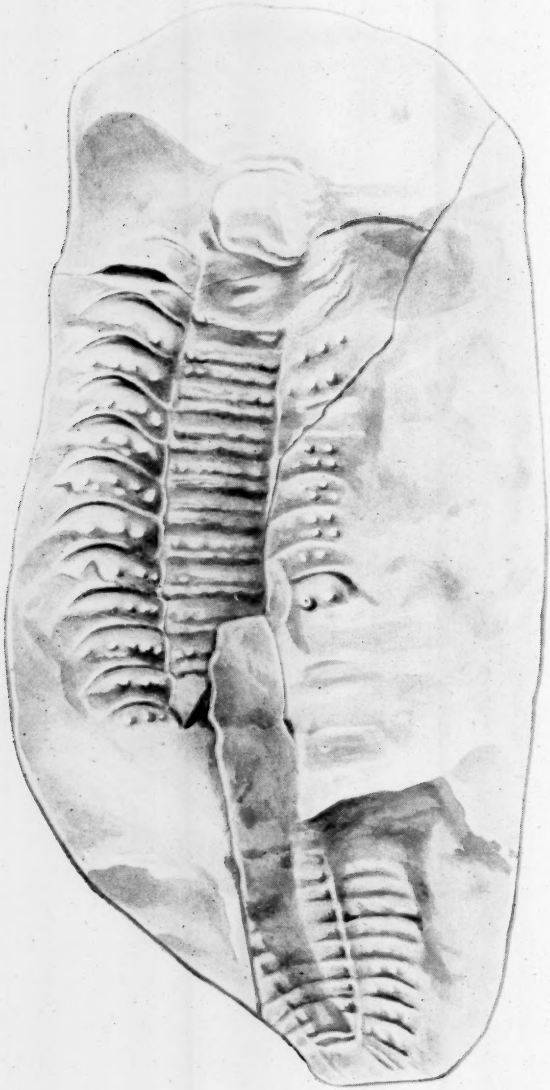
ANALYSES OF SILICEOUS DEPOSITS.

	Opal deposit, Norris Basin.[1]	Geyserite Incrustation, Giant Group, Upper Basin.[1]	Sinter from hot springs, Taupo, New Zealand. J. W. Mallet.[1]	Malayan ? Geyserite, Meunier.
SiO_2 . .	93·60	72·25	94·20	91·8
Al_2O_3 . .	1·06	10·96	1·58	traces
Fe_2O_3 . .	trace	0·76	0·17	0·2
FeO . . .	—	0·31	trace	
CaO . . .	0·50	0·74	—	
MgO . .	trace	0·10	—	
K_2O . . .	—	1·66	—	
Na_2O . .	—	3·55	—	
NaCl. . .	—	0·36	0·85	
H_2O . . .	4·71	9·02	3·06	7·5
C . . .	—	0·20	—	
SO_3 . . .	—	0·45	—	
S . . .	trace	—	—	
Tin oxide .				0·5
Total .	99·87	100·36	99·86	100·00

Weathered cassiterite-bearing quartz, having a "cavernous and tuberculous structure, whitish grey colour, with small dendritic particles in it", is very common near decomposed schists containing cassiterite-bearing quartz veins, and near weathered pegmatite veins, and there seems little doubt that the specimen sent to Meunier from near the springs was originally derived from one of these sources. Tin-mining has been carried on within a short distance of the hot spring at Cheras. It remains to add that Meunier, as Dr. Bott remarks, "could only work with a small sample sent to him in France," and that "he never saw the springs nor the water fresh from them".

At the bottom of Lahat Tin Mine in the Kinta Valley, Perak, Federated Malay States, a strong spring (not a hot spring) issues from the limestone on which rests the tin-bearing ground, and it sometimes happens that this spring brings up pieces of tin-ore of the

[1] Quoted in *Data of Geochemistry*, F. W. Clarke, 1911.



G. M. Woodward, del. *Bale & Sons, imp.*

ARTHROPLEURA MOYSEYI, *Calman, sp. nov.*

COAL MEASURES. DERBYSHIRE.

size of one's fist, and containing well-formed angular crystals. This fact has been taken, in some quarters, to support the hydatogenetic theory of the deposition of tin-ore. What happens, however, is that the limestone at Lahat Mine, as it has been proved in several other mines in Kinta, contains tin-ore in situ, and when the limestone has been dissolved by the water the freed ore is brought up by the underground stream. Several pieces of limestone containing crystals of tin-ore were found by the writer at this spot. The water was tested for tin, and no trace of the metal could be found in it. Mr. Salter's analysis of the water is given below :—

Total solids	0·146
Fe_2O_3 / Al_2O_3	0·0030
Ca O	0·05581
(equivalent to Ca C O_3)	0·09965
K Cl	0·0350
(equivalent to K C O_3)	0·0315

III.—On *Arthropleura Moyseyi*, n.sp., from the Coal-measures of Derbyshire.

By W. T. Calman, D.Sc., British Museum (Natural History).

(PLATE XXXVIII.)

THE specimen dealt with in this paper was obtained some years ago by Dr. L. Moysey, of Nottingham, and was sent by him to Dr. Henry Woodward, who has been so kind as to entrust it to me for examination.

Although the specimen has not hitherto been described, it has been several times mentioned in palæontological literature. It was first referred to by Dr. Moysey as "a complete but diminutive example akin to the *Arthropleura armata* of Jordan from Saarbrucken" [1] and was later recorded by him as "*Arthropleura*, n.sp." [2] Herr Andrée, in the second of his two memoirs on *Arthropleura*,[3] makes some observations on it, based on examination of a photograph sent to him by Dr. Moysey. Herr Andrée agrees with Dr. Moysey in referring the specimen to the genus *Arthropleura*, but concludes that it adds nothing to our knowledge of the genus, the photograph evidently not having revealed to him certain features that are clearly visible in the fossil itself. These features are well shown in the accompanying Plate, for which I am indebted to the care and skill of Miss G. M. Woodward.

Arthropleura Moyseyi, n.sp. (Plate XXXVIII.)

Description.—The specimen is contained in an ironstone nodule which has been split longitudinally. The structure is most clearly seen on the half in which the fossil is exposed in relief, but some important details have been obtained from a 'squeeze' kindly prepared for me from the counterpart by Dr. F. A. Bather.

[1] Geol. Mag. (5), v, p. 221, 1908. [2] Geol. Mag. (5), viii, p. 506, 1911.
[3] *Palæontographica*, lx, p. 303, 1913.

About the middle of the fossil the terga of eleven successive somites are visible in their natural connexions. They are transversely elongated plates of nearly uniform size, measuring about 2·5 × 8 mm. where fully exposed, and slightly convex from side to side. Each is crossed by two transverse tuberculated ridges, or rather, perhaps, rows of partly confluent tubercles. The number of tubercles in each row appears to be seven, but the surface has been much damaged and the exact arrangement is hard to decipher. On each side the terga are separated from the pleura by a well-marked groove, at the bottom of which a suture or line of articulation is visible in places.

The pleura are well preserved only on the left side of the body, where twelve (perhaps thirteen) of them can be made out. Each is a sickle-shaped plate, curving backwards to an acute point and measuring about 6·5 mm. from the point to the articulation with the tergum. Anteriorly, the pleura are slightly inclined forwards, but passing backwards along the series they come to lie transversely to the axis of the body. At or near the anterior edge of each is a strong curved ridge defined by a deep groove, behind which the surface becomes gently convex and bears a row of four or more prominent tubercles. Indications of a second row of smaller tubercles are seen on some of the pleura, but in every case the hinder edge is broken by being crushed down on the ridge of the succeeding pleuron.

The anterior portion of the fossil is obscure. Separated from the foremost tergum by a space corresponding to perhaps two somites, is a slightly convex oval area, marked off behind by a double transverse ridge. This area, no doubt, represents the head of the animal, but no further information can be obtained as to its structure or appendages.

Behind the series of somites described above, is a space of some 10 mm. in which no structure can be observed, although the pleurotergal grooves seem to be faintly traceable across it. Behind the gap the somites reappear, considerably smaller, and progressively diminishing in size towards the hinder end. About ten of them can be made out, and the pleural plates, which are visible on the right side, become more backwardly directed as they proceed towards the termination of the body, where some indication of a telsonic segment, flanked by a pair of spines, can be faintly traced. In this posterior part of the body the ornamentation is obscure, but tubercles similar to those on the more anterior somites can be seen here and there on the terga and pleura.

The total length of the body, which is slightly curved to the right, is about 60 mm., measured from the anterior margin of the head.

Holotype.—Specimen No. 34, in the collection of Dr. L. Moysey, Nottingham.

Horizon and Locality.—Coal-measures. "Yellow clays in the neighbourhood of the Top Hard Coal, probably some 30 to 40 feet below that seam. Shipley clay-pit, about 1½ miles north of Ilkeston, Derbyshire."

Remarks.—In the form of the pleural plates, their articulation with the terga, the strong crescentic ridge on each, and the tubercles with which they, as well as the terga, are ornamented, the fossil resembles

so closely the specimens of *Arthropleura* hitherto described that there can be no doubt that Dr. Moysey was at least approximately correct in referring it to that genus. Whether Andrée was right in supposing it to be a young individual (other specimens referred to the genus being of relatively gigantic size) is less certain. In any case the details of the ornamentation seem to differ from all the described forms, especially in the presence of two transverse tuberculated ridges on each tergum, and in the fact that the ridges on the pleura are nearer the anterior margin, and I propose, therefore, to regard it as representing a new species.

Systematic Position of Arthropleura.—The great importance of the specimen here described lies in the fact that it gives, for the first time, information regarding the general form of the body and the total number of somites. In this individual the number of post-cephalic somites cannot have been less than twenty-eight and may have been more. This enables us to say with confidence that, whatever the affinities of *Arthropleura* may be, it is certainly not an Isopod. Andrée, who has recently discussed the systematic position of the genus, comes to the remarkable conclusion "das in der *Arthropleura* ein Isopoden-Typus vorläge, bei welchem die Sonderung in Thorakal- und Abdominalsegmente noch nicht erfolgt ist".[1] It is very difficult to discover, in the course of Andrée's two lengthy memoirs, on what conceptions of Malacostracan phylogeny this conclusion is based. It can hardly be seriously contended nowadays that the Isopoda are the most primitive group of the Malacostraca, and that all the other Orders have been derived from them; the alternative hypothesis, which Andrée in certain passages seems to adopt, is that the common characters of the Malacostraca—the fixed number of somites, the delimitation of thorax and abdomen, and so forth—have been acquired by the Isopoda independently of the other Malacostraca. This view will hardly commend itself to anyone who realizes how many structural characters link the Isopoda, by way of the Tanaidacea, with the Cumacea and the Mysidacea.

The resemblances between *Arthropleura* and the Devonian *Oxyuropoda* were pointed out by Carpenter & Swain in their paper on the latter genus,[2] and more fully by Andrée.[3] If it be admitted, therefore, that *Arthropleura* is no Isopod, the doubts that have been cast on the Isopodan nature of *Oxyuropoda* gain in strength.

The characters of *Arthropleura*, and more especially the very remarkable structure of the sternal surface as described by Kliver[4] and by Boule,[5] seem to have no close parallel among recent Arthropoda. It may be a Crustacean of a type hitherto unknown, it may even be a very generalized and primitive kind of Myriopod; but our present knowledge does not seem to justify any more definite

[1] *Palæontographica*, lvii, p. 86, 1910 ("that in *Arthropleura* we have an Isopod type in which the separation into thoracic and abdominal segments has not yet taken place").
[2] Proc. Roy. Irish Acad., xxvii, B (3), p. 65, 1908.
[3] *Palæontographica*, lvii, p. 92, 1910.
[4] *Palæontographica*, xxxi, p. 14, pl. iv, 1884.
[5] Bull. Soc. Industrie Minérale, St. Etienne (3), vii (4), p. 630, pl. lv, 1893.

statement as to its systematic position than that it is an Arthropod *incertæ sedis*.

EXPLANATION OF PLATE XXXVIII.

Arthropleura Moyseyi, n.sp. × 2. This figure has been prepared, in the main, from that half of the nodule in which the fossil is exposed in relief, but certain details have been added from a 'squeeze' made from the counterpart.

Nodule obtained from yellow clays below 'Top Hard Coal', Coal-measures, Shipley Clay-pit, Ilkeston, Derbyshire. Original preserved in the collection of Dr. Lewis Moysey, B.A., M.B., F.G.S.

IV.—Sedgwick Museum Notes.

Strickland's Collection.

By F. R. Cowper Reed, Sc.D., F.G.S.

IT may be of interest to the readers of the Geological Magazine to know that the specimens collected by Mr. H. E. Strickland during the years 1835–6 in the Ionian Islands, the Bosphorus, and the neighbourhood of Smyrna are now preserved in the Sedgwick Museum, Cambridge. They comprise the fossils and rocks to which he referred in the following papers published many years ago in the Transactions and Journal of the Geological Society:—

1. "Geology of the Thracian Bosphorus": Trans. Geol. Soc., ser. II, vol. v, pt. ii, pp. 385–91, 1840 (read November 30, 1836).
2. "Geology of the Neighbourhood of Smyrna": ibid., pp. 393–402 (read April 5, 1837).
3. "Geology of the Island of Zante": ibid., pp. 403–9 (read November 1, 1837).
4. "On a Tertiary Deposit near Lixouri in the Island of Cephalonia": Quart. Journ. Geol. Soc., vol. iii, pp. 110–13, 1847 (read May 3, 1837).

1. The Lower Devonian fossils from the Bosphorus were named by Murchison and Sowerby in the paper quoted, and apparently were regarded as indicating a Silurian age for the beds. They are of special interest as the first ones ever brought back to England from that region for scientific study; and they include several of the species subsequently described from these beds by De Verneuil, Roemer, and Kayser. The Tertiary fossils recorded and roughly identified by Strickland from the locality termed Baloukli belong to the Sarmatian stage, and amongst them may be recognized the characteristic shell *Ervilia podolica*. These beds are described as overlaid by freshwater limestones, and the fossils which the latter contain appear to be similar to those recorded by Hochstetter from the same district.

2. The plant remains from the neighbourhood of Smyrna are probably similar to those described by Unger from these parts. Dr. Arber is now examining them.

3. The fossils from the Mesozoic and Tertiary beds of Zante are in a poor state of preservation, and require further study in the light of the work done by Fuchs and Renz.

4. The Pliocene Mollusca collected by Strickland from Lixouri in the Island of Cephalonia are well preserved, and include the original type-specimens (one of each species) on which his new species *Fusus filamentosus* and *Mitra juniperus* were based. Text-figures of these shells were given in the paper mentioned. The existence and present resting-place of these types had apparently been unknown until their recent rediscovery and recognition in the Sedgwick Museum.

There are also some British shells in Strickland's collection to which reference may here be conveniently made.

1. The original type-specimen of Strickland's species *Unio antiquior*, from the 'Fluviatile Drift' of Cropthorne, Worcester, of which a text-figure was given by Sir W. Jardine in his *Memoirs of H. E. Strickland* (London, 1858), p. clvii, and of which a description was given in the same work on p. 97, has been recently identified in the Sedgwick Museum.

2. The specimens from the Pliocene of the Isle of Man on which Strickland founded his species *Fusus Forbesi* and *Nassa pliocena* (Proc. Geol. Soc., vol. iv, pt. i, pp. 8, 9, 1843) have also been discovered in his collection. They were mounted together on the same tablet with some other broken shells of doubtful reference, and all were labelled *Fusus Forbesi*, while one good specimen of *N. monensis*, Forbes, which was also described in the same paper by Strickland (op. cit., p. 8), was mounted separately with a broken fragment and labelled *Nassa pliocena*. This confusion was pointed out to me by Mr. F. W. Harmer, who has recently described and figured typical specimens of *N. monensis* (*Pliocene Mollusca*, pt. i, p. 74, pl. iv, figs. 7, 8, 1914). Strickland published his specific definitions of *F. Forbesi* and *N. pliocena* without figures, which is unfortunate; but as his descriptions are fairly minute and precise, and as we have the very few actual specimens in his collection which he used in drawing up his definitions, we are enabled to identify and separate the type-specimens of the respective species without hesitation. There are only two examples of each which are fairly well preserved. The mistake in the mounting and labelling of these specimens seems to have been made at an early date (but by whom is unknown); for Sir W. Jardine, in 1858, in his *Memoirs*, to which reference has been made, gave four text-figures (op. cit., p. cexxviii) of four of the specimens now in the Sedgwick Museum; two of these (figs. 1) were called *F. Forbesi*, and two of them (figs. 2) *N. pliocena*. The two left-hand figures (figs. 1) represent shells belonging to *F. Forbesi*, but the right-hand and smaller one of fig. 2 is *N. monensis* as identified by Mr. Harmer; the other fig. 2 (second one from the right) is the broken fragment mounted with it of which the specific reference is doubtful. The true *N. pliocena* was thus not figured by Sir W. Jardine, and under these circumstances it is of importance that the actual specimens which Strickland used in describing this species have been discovered. Lamplugh (Geol. I. of Man, Mem. Geol. Surv., 1903, pp. 336, 475) includes *N. pliocena*, Strickl., in *N. serrata*, Brocchi

V.—Some Points in the Eolithic Controversy.[1]

By S. Hazzledine Warren, F.G.S.

THE controversy which has raged round the problem of the Eoliths seems little nearer a satisfactory solution than it was upon the publication of Sir Joseph Prestwich's papers of 1889, 1891, and 1892.[2] The present article is an endeavour to place certain sceptical considerations before the readers of the Geological Magazine.

In two papers published by the Anthropological Institute,[3] I showed that crushing and mechanical movement under pressure were capable of reproducing the edge-chipping which is characteristic of the eoliths of Kentish type. One of the most notable forms produced by such processes is that of the chipped notch, either single or in various combinations, such as the double notch with point (often called the bow-shaped scraper), two notches crushed out from opposite sides of a tabular flint producing an astonishing simulation of a drill with reverse working, or notches in combination with other edge-chipping.

It is understood that mechanical force can only effect a reproduction of an eolith when operating upon suitable raw material: that is to say, upon flints of plano-convex or tabular form such as those of which the Kentish eoliths are made. In fact, it is only in working upon this special class of raw material that an eolith of this type can be formed by any process, whether by design or accident.

With regard to the criticisms of Mr. F. J. Bennett,[4] it is true that my theory could not stand upon the results of a machine, if this were in the way in which it is represented by him. I have used many different processes in the application of mechanical force in order to investigate the chipping properties of flint, and have attempted, as will be seen in the sequel, to apply this knowledge to what we see of the processes of nature.

Again, Mr. Bennett says that suppose I could perfect this method so as to produce palæolithic and neolithic implements, would this prove that these implements were non-human in origin? In answer to this one can only say that mere mechanical force, however it may be applied, *does not produce true implements.* I do not therefore think that Mr. Bennett's argument carries much weight. We cannot in science go into the question of what we might believe in the event of the facts which are the foundation of our theories proving to be the opposite of that which they are observed to be. If such circumstances were realized I think we should most of us be constrained to modify our opinions. We must surely make our theories accord with the facts as they are, not with imaginary facts which might conceivably be but which are not.[5]

[1] This article, owing to pressure of other matters, has been very long delayed, for which circumstance the Editor offers his apologies to the author.

[2] J. Prestwich, Quart. Journ. Geol. Soc., vol. xlv, p. 270, 1889; vol. xlvii, p. 126, 1891; Journ. Anthrop. Inst., vol. xxi, p. 246, 1892.

[3] S. H. Warren, *Man*, 1905, 103; 1906, 3; Journ. Anthrop. Inst., vol. xxxv, p. 337, 1905.

[4] F. J. Bennett, Geol. Mag. 1913, p. 47.

[5] In the same number of the Geological Magazine (1913, p. 46) a letter also appeared from Mr. J. Reid Moir in which he raised certain

The main line of Mr. Reid Moir's argument is this[1]: that we, who take the sceptical side, have no case until we can show reproductions of the sub-Crag chipped flints made by an unguided natural force. This is a perfectly safe challenge, and if it is in itself a sound argument it is unanswerable, for I have never used an unguided natural force in the conduct of flint experiments. But this which is true of my experiments is equally true of those which have been conducted by Mr. Reid Moir.

But is it a sound argument? Let us apply it to other cases. Firstly, let me say: "I claim a chair to be an artificial product, and anyone who claims a chair to be natural must produce one made experimentally by an unguided natural force." This seems to be right, and to confirm the soundness of my logic. But suppose I replace the word 'chair' by 'crystalline diamond'. Can anyone reproduce a perfect crystal of a diamond, with its polished facets, by an experimental process coming within the designation of an unguided natural force? I think not. Such things, if they are to be done successfully, require great care in the arrangement and control of the methods adopted.

In fact, to speak of experimenting with an unguided natural force is almost a contradiction in terms. The object of scientific experiment is to discover what will happen under definitely known or controlled conditions.

Mr. Reid Moir has fallen into the error of supposing that a few inadequate experiments can show everything that Nature can do. Experiments cannot easily reproduce natural conditions, and if they do not adequately reproduce natural conditions they cannot *directly* show the product of those conditions.

Sir Ray Lankester has graphically described the grinding of one flint against another beneath the pressure of an ice-sheet in the formation of the striations found upon their surfaces. Have the experiments, upon the negative results of which Mr. Reid Moir relies, reproduced such conditions? Of course not![2]

Mr. Reid Moir argues that because certain special and very limited experiments have not produced a given result, that therefore natural agencies cannot produce that result. If I had argued (upon the same method but in the contrary sense) that because eoliths can be reproduced by mechanical means, *and without taking other evidences into account*, that therefore natural agencies have made the eoliths, the criticism of my opponents would be justified. This has

personalities. These were the outcome of an unfortunate misunderstanding, and I have Mr. Moir's authority for stating that he has withdrawn them. I am particularly glad of this, as one is naturally desirous of discussing a theoretical question upon its own intrinsic merits, and in a spirit that is personally friendly towards those from whom one differs.

[1] J. Reid Moir, Abstracts Proc. Geol. Soc., November 28, 1913, p. 16; and elsewhere.

[2] In this I am taking the theory of my opponents as it stands. It may be correct, but personally I am of opinion that the striations in question are due essentially to solifluction, possibly, but not necessarily, assisted by the additional weight of snow or ice. From the point of view of the flint chipping the matter is not important, as either the soil or the ice would furnish the necessary pressure.

not been my argument, as anyone who will read my published papers may find.

In my opinion, the object of *the investigation of flint is to ascertain by experiments its chipping properties.*

This investigation has shown, as I have indicated in an earlier part of this article, that when suitable raw material is subjected to a force of crushing or of differential movement under pressure eolithic chipping inevitably takes place.

Now one of the most notable features which is associated with the eoliths in the field is the striation of the surfaces of the flints. Whether this striation be due exclusively to ice-action, as some have claimed, or whether it be more commonly due to the active process of solifluction or *soil-abrasion*.[1] (as I have previously suggested that it might be named), does not affect the immediate question of the eoliths. In either case, striation of the flint surfaces indicates movement under pressure.

I venture to ask that if experimental movement under pressure inevitably produces eolithic edge-chipping, is it so unreasonable to suppose that natural movement under pressure will also have the same chipping effect when operating upon similar material?

I hope to describe before long the experiments which I have been conducting for the purpose of discovering the amount of chipping produced by differential movement under various pressures.[2] And also the comparison of this with the amount of the subsoil pressure which falls upon stones in different soils according to their superficial area and their depth beneath the surface. This is a somewhat complicated subject and one which cannot be dealt with adequately within the compass of a short article. I will only say here that there is no inherent difficulty, so far as the necessary pressure is concerned, in the chipping of the Kentish type of eoliths by the action of soil-abrasion during the sliding or solifluction of drift deposits.[3]

With regard to the larger chipping upon the sub-Crag flints, it is perfectly true that this has not been reproduced experimentally by mechanical force. But I am unable to follow Mr. Moir in viewing this as a matter of such great moment, for the simple reason that no experiment of differential movement under the pressure which exists beneath 20 or 30 feet of drift, to say nothing of the weight of an ice-sheet, has yet been made upon flint. In making such experiments it would be necessary to take into account the structure, size, shape, and flaking qualities of the raw material used; for a result which is inevitable upon one piece of flint is unattainable upon another.

For the present one can only judge of the sub-Crag flints upon general lines, and by inference from the known lesser to the unknown greater. In my judgment the sub-Crag chipping is only what one might expect to take place where forces of greater magnitude are operating upon larger material.

[1] S. H. Warren, Journ. Anthrop. Inst., vol. xxxv, p. 349, 1905.

[2] Since this was written the paper has been read at a joint meeting of the Royal Anthropological Institute and the Prehistoric Society of East Anglia on February 17, 1914, but it is not yet published.

[3] See also Abstracts Proc. Geol. Soc., November 28, 1913.

But coming again to more general points, it is argued that the palæoliths cannot have been the first human implements, but that they must on *a priori* grounds have been preceded by an 'eolithic' stage of culture. It is true that everything must have its beginning, but at the same time we do not find in the development of human arts and crafts that any method becomes dominant until it has reached a certain degree of excellence and practical usefulness.

The most primitive implement of stone is the simple pebble, used for purposes of hammering or crushing [1] In its simplest form it is not an artifact, and cannot always be determined as a human implement. It goes right through the human period, and is still occasionally used by ourselves at the present day.

Apart from this, the most primitive implements among modern savages are not implements of stone, but those made of wood, thorns, the teeth and claws of wild animals, shells, and the like. We may call this culture the *age of wood*. There are races living to-day who have scarcely reached the stone age—or, as is perhaps more probable, who have gone back by a process of atavism to a condition which is practically a pre-stone-age culture.[2]

The age of metal did not supersede the age of stone until the working of metal had sufficiently advanced to make its general use advantageous. And that, I think, is the general order of things; it seems inevitable that it should be. Why is it theoretically necessary for the passage from the age of wood to the age of stone to have been an exception?

One of the first needs of mankind in all ages is a cutting instrument.[1] We do not find an important stage in human cultural evolution represented by vast numbers of abortive attempts at making cutting instruments of metal. Yet it is confidently alleged that the earliest phase of the stone age ought (*a priori*) to be represented by instruments of stone that will not cut, and the eoliths are held to fulfil this expectation. I do not understand why the earliest group of stone implements should be incapable of cutting.[3]

I am not forgetting that large numbers of the eoliths—supposing them to be human implements—belong to the scraping group of cutting tools. But even scrapers require to have a definite edge, which is often not very apparent on the eoliths.

[1] [It may not be without interest to record that the late Dr. Richardson (F.R.S. Tas.) informed me (many years ago) that on the old beaches along the coasts of Tasmania he had found *very ancient native 'middens'* marked by heaps of bivalve shells which had been opened with *sharp-edged stones*; in other spots the middens consisted of broken univalves (*Tritons*, etc.) whose whorls had been crushed with *round stones*. In each case the appropriate implement was found at that locality with the shells of the particular molluscs upon which the natives had subsisted.—ED. GEOL. MAG.]

This is a very interesting point. Taking Dr. Richardson's conclusion with regard to the "sharp-edged stones" as correct, they come within the group of cutting instruments. The round stones belong to the primitive pebble-hammers. The eoliths cannot claim to belong to either group.—S. H. W.

[2] W. J. McGee, "On the Seri Indians": Bull. Bureau Amer. Ethnol., 17, pt. i, 1896.

[3] See also G. & A. de Mortillet, *Le Préhistorique Origine et Antiquité de l'homme*, 3rd ed., p. 143, 1900. The argument here is that the Chelléen instrument is essentially primitive.

If the eoliths are scrapers, the group is not primitive, but highly specialized. It hardly seems credible that such high specialization of form (and presumably of function) should be reached with implements that, viewed as practical tools, are less efficient than naturally broken stones which may be picked up ready made.

It is urged in defence that if we do not know the uses of the eoliths, neither do we know the uses of the palæoliths. This is hardly the point; *it is not their uses, but their usefulness.* In contrast with the eoliths, the early palæoliths, as so ably shown by De Mortillet, are primitive and generalized in form, and yet they are efficient cutting tools.

We must now consider the appeal to history. Practically every one who has written in defence of the eoliths has made a strong point of the appeal to the history of the objections formerly urged against the palæoliths. It seems to me that every case must be judged upon its own merits; to give an illustration, we cannot prove that *Eozoon* is truly organic by the appeal to history; to the history, that is, of the controversy which formerly raged round the rival claims of 'sports of nature' and 'petrifactions'. Further, in pouring our contempt upon those who formerly opposed the contemporaneity of man with extinct animals we must not forget that the greater number of the supposed facts upon which the earlier speculators based their belief have long since been discredited and forgotten. We now know that Mr. Frere's discovery in 1797 of flint implements with remains of the Mammoth at Hoxne was correct, but it was not only—or even perhaps chiefly—upon such evidences that the earlier speculators really based their belief, but rather upon such things as the 'homo diluvii testis' of Œningen, which is now known to be an extinct salamander. The Rev. J. McEnery's discovery in 1825 of flint implements and extinct mammalia at Kent's Cavern has also been fully confirmed by Pengelly, but if we go a little more carefully into history we shall find that in a large number of cases the side of the opposition was right and has won the day.

So that if the appeal to history were admitted as scientific evidence (which I do not think it is) it would be at best a dangerous two-edged sword to wield.

A better argument that has been urged against my point of view by Professor Schwartz and Sir Hugh Bevor[1] is that it entails the attribution of chipping, which is in all cases essentially similar, to different natural agencies when found in various geological deposits. These authors argue that the only cause which can be postulated for this uniformity of effect, wherever it may be found, is Man.

Unfortunately, another of my opponents, Mr. Reid Moir,[2] urges, with equal show of reason, that the groups of eolithic chipping which are found in different geological deposits are essentially different from each other. This author argues that natural causes must

[1] A. Schwartz & H. R. Bevor, Mem. and Proc. Manchester Lit. and Phil. Soc., vol. liii, p. 29 of reprint, 1909.

[2] J. Reid Moir, Abstracts Proc. Geol. Soc., November 28, 1913, p. 16; and elsewhere.

always chip flints in the same way, and that it is only man who can chip them in different ways.

Thus my opponents in traversing each other show the logical unsoundness of their own arguments.

Another objection which has been raised, notably by Mr. C. J. Grist,[1] against the theory of the origin of eoliths by movement under pressure in geological deposits, is that there are certain superficial drifts in which solifluction has had an obvious share which at the same time do not yield eoliths. One must take into consideration in such cases—

1. Whether the drift in question contains an abundance of raw material of suitable size and shape for the making of eoliths.
2. Whether the flint surfaces show striations similar to those which are characteristic of the 'eolithic' Chalk down drifts.

If these two conditions are realized, then the case is a valid objection against my theory; and it requires to be given its due weight. If, on the other hand, this is not so, then the objection has no application against my theory, because the conditions of that theory are not fulfilled. This particularly refers to the eoliths of Kentish type; but, as I endeavoured to show in the paper published in 1905, there are other groups of eoliths, standing somewhat apart from these, which I believe owe their form to different causes.

In general answer to the objections of Professor Schwartz and Sir Hugh Bevor, Mr. Reid Moir and Mr. C. J. Grist, which are referred to above, it is my experience that *the characters of the edge-chipping of the group of eoliths found in any geological deposit is dependent partly upon the character of the raw material which is locally available and partly upon the geological forces which have acted upon that material.* The direct evidences for the operation of these forces are found, broadly speaking, in striation of the flint surfaces indicating ice- or soil-abrasion, and contusion and reticulation of the surfaces indicating water-abrasion.

If the eoliths were human implements it appears to me that we should expect that their characteristics would be independent of associated geological forces, but would be dependent upon the relative ages of the deposits containing them. As a matter of fact we do not find that earlier deposits consistently contain more primitive eoliths and later deposits more advanced eoliths. In a broad view of the evidences, the characteristics of eolithic groups bear no discoverable relation to the age of the deposits containing them.

There are also other processes and conditions of flint chipping which have their own special characters, such as dead crushing without movement,[2] and consequently without associated striations, but the two processes mentioned above are generally the most important.

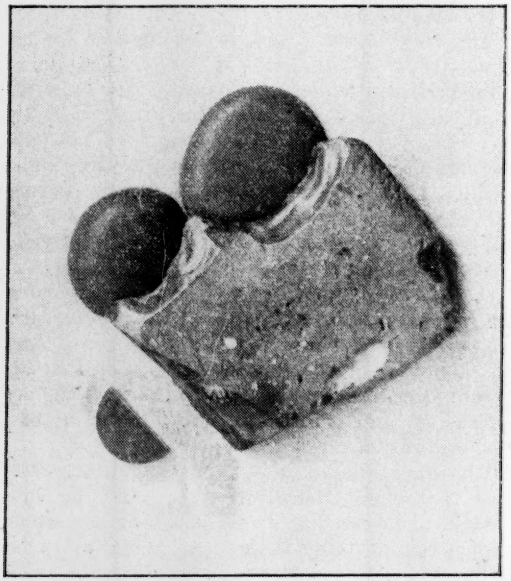
There is only one way to become acquainted with the characters of flint chipping which belong to different mechanical processes, and that is by first-hand knowledge gained by following the work out for oneself in the simple endeavour to find the truth.

[1] C. J. Grist, Journ. Anthrop. Inst., vol. xl, p. 198, 1910.

[2] This is particularly evident in the Reading Beds at Harefield, where I first found these forms on a recent visit of the Geologists' Association.

We have still so much to learn that it is perhaps rash to be too definite; at the same time I have no hesitation in expressing my opinion. I believe that when the subject of flint chipping comes to be understood upon a scientific basis it will no more be possible to regard the eolithic groups (as a whole)[1] as human implements than it is possible, now that anatomy is understood, to regard the fossil salamander of Œningen as being veritably the skeleton of a human being who witnessed the deluge.

In conclusion, I would like to express my indebtedness to the articles which have been published on the sceptical side by Mr. F. N. Haward and Mr. W. H. Sutcliffe, to the evidences brought before the British Association by Professor Sollas, and to other papers published in this country and upon the Continent.[2]



The figure shows a piece of tabular flint with two notches crushed out of its edge by pressure against two pebbles, as illustrated by the photograph. The half-circle by the side has a diameter of 1 inch, and is placed there to show the scale.

[1] The question of the selection of, say, 2 per cent (as has been suggested) of the eoliths as being more probably human implements than the remainder is a very difficult one. There is much to be said in its favour, but, on the other hand, the members of the eolithic groups have so much essentially in common that to my mind it seems more logical to consider that they must stand or fall together.

[2] F. N. Haward, Proc. Prehist. Soc. East Anglia, vol. i, p. 185, 1912; vol. i, p. 347, 1913; W. H. Sutcliffe, Mem. and Proc. Manchester Lit. and Phil. Soc., vol. lvii, No. 7, 1913; M. Boule, *L'Anthropologie*, vol. xvi, p. 266, 1905; W. G. Smith, *Man*, 1907, 99; 1908, 53; H. Breuil, *L'Anthropologie*, vol. xxi, p. 385, 1910; P. Sarasin, *Verhand. Naturfor. Ges. Basel*, vol. xxii, p. 1, 1911. Further references may be found in these papers.

REVIEWS.

I.—Prehistoric Man.

THE ANTIQUITY OF MAN IN EUROPE. By JAMES GEIKIE, LL.D., D.C.L., F.R.S. 8vo; pp. xx, 317, with 4 maps. Edinburgh: Oliver & Boyd, 1914. Price 10*s.* 6*d.*

PROFESSOR JAMES GEIKIE has made the Munro Lectureship, which he held in 1913, an opportunity for restating his views on the interpretation of the Pleistocene deposits of Western Europe, with numerous references to the latest discoveries. The result is a most readable volume, which will be welcomed equally by the professed geologist and by the intellectual onlooker who desires a broad statement without too much confusing detail. As might be anticipated from the nature of the author's own researches, the geological evidence alone is dealt with; and the caution engendered by these lifelong researches prevents Professor Geikie from giving much encouragement to those who venture to express geological time in terms of years. He is satisfied when he has pointed out how many and how great changes have taken place in this part of the world since man first appeared here.

It is clear that man has lived in Europe since the beginning of the Pleistocene period, but Professor Geikie thinks that more satisfactory evidence is needed than that of chipped flints before his presence in the Pliocene becomes certain. He specially doubts the evidence of the so-called eoliths, for those found "in the older Tertiary formations cannot be distinguished from those met with in Miocene, Pliocene, and even Pleistocene deposits". Hence, if we accept them "as proofs of man's existence in Eocene and Oligocene times, we must admit that in his case—and in his case alone—evolution must have been at a standstill during a prodigiously extended period".

The first lecture deals with the animals and plants which lived in Europe during Pleistocene times, and is illustrated with several good woodcuts and photographs. The conclusion seems inevitable that considerable changes of climate have occurred—that the theory of great annual migrations to account for the apparent mingling of mammalian remains is negatived by the evidence of the plants, "which could not have indulged in such feats of travel."

The next two lectures refer to the testimony of the caves, and briefly describe the 'culture-stages' recognizable in the succession of stone implements. The interpretation of the cave-deposits themselves is specially discussed from the geological point of view, and many interesting results are arrived at. A description of the Schweizersbild cave, near Schaffhausen, Switzerland, shows tundra, steppe, and forest faunas in succession from the later part of the Palæolithic to the early part of the Neolithic period.

The lecture on the river-drifts gives a concise account of Commont's latest researches in the valley of the Somme, and Professor Geikie concludes that there must be some accidental mixing of the mammalian bones in the deposits hitherto studied in the valley of the Thames. He also emphasizes the importance of Mr. Hazzledine

Warren's discovery of an Arctic plant-bed in the valley of the Lea, which seems to date back to a late phase of the Pleistocene period.

Glacial phenomena and the glacial deposits form the subject of the remaining lectures, and there is much interesting matter which has not hitherto been accessible in so concise a form. The short account and interpretation of the breccias and associated deposits round the rock of Gibraltar are specially welcome, and it would be interesting to test the results by reference to other parts of the Mediterranean area.

Professor Geikie concludes with a valuable summary of the history of the Pleistocene period—its succession of glacial and interglacial episodes—as he understands it, and provides a clear statement which will be very acceptable to students who are occupied with the examination of superficial deposits. The short appendix referring to recent discoveries and various technical matters will also prove helpful.

II.—The Geology of Lyme Regis and Charmouth.[1]

THE Geologists' Association of London has again surpassed itself. Not content with issuing 6 in. maps to illustrate Rowe and Sherborn's contributions to the Chalk of England, they have now published W. D. Lang's paper on the coast of Lyme Regis and Charmouth, and illustrated that with maps on the scale of 25 inches to the mile. This is indeed geology *de luxe*, and enables the amateur and the professional both to collect and zone their specimens with precision of the highest value in any future work. Mr. Lang's text occupies some sixty pages, and appears to be a model of conciseness and clarity, in which the Lias, the Cretaceous, and the post-Cretaceous beds are fully dealt with. The maps, printed by Weller & Graham from Ordnance Survey transfers, are all that could be desired, and are indispensable to any one visiting the district. Truly the members of the Geologists' Association are fortunate in their publications when so much solicitude is shown for the needs of the local worker. We believe that this is the first occasion on which 25 in. maps have been printed and published by any authority.

III.—The Wilds of Maoriland. By J. M. Bell, M.A., Ph.D. pp. xiii + 253, with 8 coloured plates, numerous illustrations, and maps. London: Macmillan, 1914. Price 15*s*.

ALL those geologists and geographers who are acquainted with the excellent work done by Dr. Mackintosh Bell during the six years spent as Director of the Geological Survey of New Zealand will turn with interest to this book, which gives in a somewhat popular form an account of his wanderings in that fascinating country. It is clear that geological work in New Zealand involves not only a laborious existence, but difficulty, privation, and even danger in the less-known and mountainous regions. In the more interesting parts

[1] Proc. Geol. Assoc., vol. xxv, pts. v, vi, 1914, pp. 360, plates 39 and 40, folding table, and 3 coloured geological maps and 1 vertical section between West Haye Water and Lyme Regis. Issued October 27, 1914. Price 5*s*. complete.

of the country there are no bridges over the rapid rivers, and the roads are of the most primitive type; shelter and food also are hard to find. But the geology and scenery well repay the hardships incurred. In the North Island there are the wonderful volcanoes of the Taupo zone: it may be mentioned that the map of the Tarawera region in this book is specially clear and interesting, and a good account is given of the eruption in 1886 that destroyed the ever-to-be-regretted pink and white terraces. Again, in the South Island there is the wonderful glacier system of the Southern Alps; of these some beautiful pictures are provided. Perhaps, however, the most striking feature of the topography of New Zealand is the district of Milford Sound in the extreme south-west. Here is found fiord scenery even more wonderful than that of Norway.

The graphic descriptions of scenery here given are illustrated by many photographs and artistic coloured plates; there are also two excellent maps, one of the central part of the Southern Alps (the glacier district) on a fairly large scale, the other a general map of the whole island, indicating the regions described in the text.

The last chapter, on the geography and climate of New Zealand, gives an excellent short account of the chief physical features of the islands. It is pointed out that perhaps no other country in the world can show such a wonderful variety of physical features, and yet the whole area of the Dominion is less than that of the British Isles. New Zealand is as yet essentially a pastoral country, but its mining is of increasing importance, and the day will surely come when the enormous water power available in the mountains will be turned to account to supply manufactured goods for the great population that must eventually grow up both in the pastoral parts of the country itself and still more in Australia, where over vast areas water power is conspicuously lacking.

This interesting and well-got-up book should do much to draw the attention of geologists, explorers, and mountain climbers to a field where all will find much scope for their energies, with a probable harvest of results of scientific and practical value.

IV.—Canadian Geology.

Kewagama Lake Map-Area, Quebec. By M. E. Wilson. Canada, Department of Mines, Geological Survey Memoir 39. pp. vi + 139 and map. 1913.

THE area described in this memoir lies in North-Western Quebec, and is part of the great glaciated pre-Cambrian plateau which occupies so much of Canada. The basal rocks consist of an Archæan complex, which includes metamorphosed sediments and volcanic rocks, and batholithic intrusions of granite and gneiss. The former have generally been correlated with the Keewatin, but the author considered this correlation to be somewhat doubtful, and suggests that the name *Abitibi* group be substituted. In the northern part of the region the rocks belonging to this group are largely of volcanic origin, including basic to acid types, but more especially those of intermediate composition. The ancient lavas of the Abitibi very

commonly possess the pillow or ellipsoidal structure which has now been recognized in so many different parts of the world. A very useful bibliography and discussion of the origin of pillow lavas is given, and the author comes to the conclusion that, as elsewhere, the structure is to be attributed to extrusion under water. By contact metamorphism due to later batholithic intrusion the more basic rocks have been transformed into hornblende schists and amphibolites, and the more acid types into sericite schists. In the southern part of the area, the Abitibi group is represented by sediments more or less metamorphosed. They are distinguished as the *Pontiac* series, their stratigraphical position relative to the volcanics being still unsettled.

Into the Abitibi rocks granitic batholiths are intrusive. Locally the granite passes into diorite, and where the rock is rich in hornblende the change of composition can often be traced to the assimilation of basic volcanic rocks. To quote the author: "There appears to be complete gradation from blocks of rocks (xenoliths) which undoubtedly belong to the Abitibi group to hornblende granite." The intrusions made room for themselves by lifting and thrusting aside the surrounding rocks and by sub-crustal stoping, but the relative importance of these three methods are, unfortunately, not discussed.

Lying unconformably on the denuded surface of the rocks already described is a group of clastic sediments which constitute the *Cobalt* series. At the base of the series and often at the summit conglomerates are found. Their possible modes of origin are thoroughly discussed, and the evidence (undecomposed and angular character of the pebbles and the abundance of 'soled' and scratched examples) is held to point to a glacial origin. The intermediate beds are of lacustrine origin and seem to represent an interglacial episode. The whole series is classed as Huronian, no more detailed correlation being possible.

Of probably later date than the Cobalt series are a large number of diabase dykes and an isolated and unique intrusion of syenite porphyry.

The author describes the mantle of glacial and post-glacial (lacustrine) deposits, and concludes with some account of the ore deposits and economic possibilities of the district. The outstanding features in the geological history of the region appear to have been—(1) The stupendous vulcanism of its early history. (2) The undisturbed continental character of the region, interrupted only by a short period of marine submergence in Silurian time. (3) The occurrence of two prolonged eras of denudation, terminated in each case (Huronian and Quaternary) by continental glaciation.

ARTHUR HOLMES.

V.—THE ARCHÆAN GEOLOGY OF RAINY LAKE RE-STUDIED. By ANDREW C. LAWSON. Canada, Department of Mines, Geological Survey Memoir 40. pp. vii + 115 and map. 1913.

IN 1887 Dr. A. C. Lawson described the pre-Cambrian geology of the Rainy Lake region of North-Western Ontario in a memoir which has since become classic. In it he described two series of

metamorphic rocks which were proved to be older than the 'Laurentian': the Coutchiching, a series of mica-schists and paragneisses, and above it the Keewatin, a series made up largely of volcanic rocks. The conclusions then arrived at as to the stratigraphical position of the Coutchiching have been called in question by the United States Geological Survey and by the International Committee on Geological Nomenclature. They denied the existence of such a series *below* the Keewatin, and decided that on at least one line of section the rocks referred to the Coutchiching were certainly stratigraphically higher than parts of the Keewatin. This controversy naturally led to a re-examination of the district by Dr. Lawson, and his revised conclusions are now before us. In all its essentials he maintains his original position, and having forcibly presented his case with a mass of detailed and convincing field evidence, he challenges his critics to deny the superposition of the Keewatin upon the Coutchiching as he mapped them a quarter of a century ago.

The International Committee of 1905 decided that the term 'Laurentian' should be restricted to the granites and gneissose granites which antedate or protrude through the Keewatin and which are pre-Huronian. Since then it has become increasingly evident that a great proportion of the igneous rocks mapped as 'Laurentian' are of post-Huronian age. In the Rainy Lake region at least two periods of granite intrusion, widely separated in age, have been recognized. For the older of these Dr. Lawson proposes to retain the term Laurentian in accordance with the now accepted definition, and for the later (post-Huronian) he suggests the term *Algoman*, from the old district of Algoma, in which such intrusions extensively occur.

Dr. Lawson discusses the mechanics of batholithic intrusion as illustrated in his area, and comes to the conclusion that the facts are somewhat difficult to harmonize with Daly's conception of stoping on a large scale. The folded and faulted structures of the roofs are suggestive of a mode of intrusion analogous to that of a laccolith.

Only two divisions of the Huronian formations are recognized, the Animikie, as shown in the classification given below, being separated from the Upper Huronian (Middle Huronian of Van Hise and Leith) by the intrusion of the Algoman granites and by the immensely long period of erosion which followed. The pre-Cambrian sequence suggested by Dr. Lawson is as follows:—

ALGONKIAN	Keweenawan.
	Unconformity.
	Animikie.
	Eparchæan interval.
ARCHÆAN	Algoman granites, gneisses, etc.
	Irruptive contact.
	Upper Huronian.
	Unconformity.
	Lower Huronian.
	Unconformity.
	Laurentian granites, gneisses, etc.
	Irruptive contact.
	Keewatin. / Coutchiching. } Ontarian.

In the Rainy Lake region the Steeprock series of sediments (including fossiliferous limestone) and volcanics is tentatively correlated with the Lower Huronian. Following an interval of uplift, deformation, and erosion, came the Seine series of sediments, which is tentatively correlated with the Upper Huronian. Dr. Lawson's memoir is of absorbing interest, and will strongly appeal to all those who find a fascination in the more ancient rocks of our aged planet.

ARTHUR HOLMES.

VI.—PRELIMINARY REPORT ON THE SERPENTINE AND ASSOCIATED ROCKS OF SOUTHERN QUEBEC. By JOHN A. DRESSER. Geological Survey of Canada. Memoir No. 22. pp. viii + 103, with 2 folding maps. 1913.

THE serpentine belt consists of a series of basic igneous rocks intrusive through sedimentary rocks of Palæozoic age. Although on account of its economic importance serpentine gave its name to the belt, it is actually the least abundant of the principal rocks of the series. It is of two types, in the one resulting from the alteration of peridotite and in the other of pyroxenite, but both were members of a series of intrusive rocks differentiated from a single magma. The belt includes two minerals of great economic importance—asbestos and chromite. The asbestos, which is mineralogically chrysotile, is of two kinds, one, which is found in veins, being longer, stronger, and more valuable than the other, which occurs parallel to the cleavage of the rock. The mines are by far the largest of the kind ever worked, and provide at the present time about 90 per cent of the world's supply, the annual production amounting to about £500,000. Chromite is shipped mainly to the United States, where it is used in the manufacture of bichromates for use in dyeing textiles and tanning leather, for pigments used in printing and painting, in making chrome steel, and in lower grades for lining furnaces. Among the other minerals found are chalcopyrite, pyrite, stibnite and other antimony minerals, platinum (in minute amount), diamond (in crystals of good quality, but far too tiny for gem purposes), vesuvianite, and magnetite.

VII.—PALÆOZOIC CIRRIPEDES FROM SWEDEN.

OM SVENSKA SILURCIRRIPEDER. Af JOH. CHR. MOBERG. Lunds Universitets Årsskrift, N.F., Afd. 2, Bd. 11, No. 1. Kgl. Fysiografiska Sällskapets Handlingar, N.F., Bd. 26, No. 1. pp. 20, 2 pls. July, 1914.

THIS interesting paper does not deal with *the* Silurian (*sensu lato*) cirripedes of Sweden, but only with some of them, the inception of the work being due to a recent discovery of cirripedes in the Black Trinucleus Shales near Ullnäs in Ostrogothia, which led to a comparison with material that had accumulated from the same beds in Dalecarlia. The three new species described are all from the Black Trinucleus Shales, but figures are also given of a possible *Plumulites* from the Colonus Shales of Scania, a doubtful *Turrilepas* from the Leptæna Limestone of Dalecarlia, and a plate from the Silurian of Gotland assigned to *Turrilepas wrightiana*.

In the course of a brief survey of what has already been published on the Silurian and Ordovician cirripedes of Sweden, the author points out that the name *Pollicipes validus*, which C. W. S. Aurivillius in 1892 applied to a scutum from Gotland, was preoccupied by Steenstrup for a Cretaceous species. For the Gotland fossil he therefore proposes the new name *P. aurivillii*. It may here be remarked, since Professor Moberg has not troubled to do so, that recent work on Cretaceous cirripedes, especially that of Mr. T. H. Withers, shows the high improbability, if not impossibility, of there being in the Silurian any representatives of either *Pollicipes* or *Scalpellum*.

The species described by Professor Moberg are referred to *Lepidocoleus*, *Turrilepas*, and *Plumulites*, and he precedes his description of them with a discussion of those three genera.

For some reason British palæontologists have persisted in regarding *Plumulites* Barrande as a synonym of *Turrilepas* H. Woodward. In both genera the visible plates are arranged in four vertical rows; but, as Professor Moberg points out, in *Turrilepas* these form two principal rows of keeled plates and two outer rows of much smaller unkeeled plates, all of which rows alternate with one another. In *Plumulites*, on the other hand (to which genus Professor Moberg refers the species generally known in this country as *Turrilepas scotica* and *T. peachi*), the so-called dorsal face shows a double row of median plates unkeeled and abutting, not alternating; and on each side is a row of large, kite-shaped plates. It is not easy to describe these fossils in few words, but any one who will compare the figures conveniently brought together on a single plate by Professor Moberg will have no difficulty in appreciating their complete difference of structure.

From both of these genera *Lepidocoleus* Faber differs in being composed of only two vertical rows of plates. Hitherto only three species of this genus have been described, namely, the genotype, originally known as *Plumulites jamesi* Hall & Whitfield, from the Hudson River group of Cincinnati, *Lepidocoleus sarlei* J. M. Clarke, from the Niagara Shales of New York, and *L. polypetalus* J. M. Clarke, from the Lower Helderberg Group of New York. Professor Moberg now introduces a new species, *L. suecicus*, found in Ostrogothia and in various localities in Dalecarlia; he has presented the British Museum with specimens from Ullnäs (regd. I 16018–I 16022), and describes a specimen already in the Museum collected at Svälasgård, Skattungbyn, Dalecarlia (regd. I 14425). Since Professor Moberg says that this is the first species known outside North America, it may be as well to notify the existence of other European species, namely, a large form detected by Mr. Withers among our Wenlock fossils (Brit. Mus. 59058 and 55032), and one from the Middle Devonian near Olmütz, Moravia, submitted to me as a cystid stem in 1912 by Dr. M. Remeš.

Of *L. suecicus* Professor Moberg gives good figures and a detailed description, but excuses himself from a diagnosis or comparison with other species on the ground that previous descriptions are not precise enough. Examination of material in the British Museum

from the Trenton, Utica, Lorraine, and Richmond groups of various North American localities, comprising specimens referred to *L. jamesi*, permits one to accept *L. suecicus* as a distinct species. Not only is it actually of greater dimensions, as Professor Moberg says, but the height of the plates relative to their width is greater; and *L. jamesi*, which is perhaps nearest to it in this respect, has the lines of growth more prominent. Professor Moberg has been unable to find in *L. suecicus* "any trace of the peculiar fine sculpture between the growth-lines, which according to Ruedemann characterises *L. jamesi*". The fine striæ at right angles to the growth-lines, ending on them in slight beads, just as described by Ruedemann, are visible in our specimens of *L. suecicus* (I 16020, I 16022). Dr. J. M. Clarke's description of *L. sarlei* and other species (*Amer. Geol.*, vol. xvii, p. 137, 1896) suggests that the plates merely abut on the middle (so-called dorsal) line, and that they alternate; but an excellent specimen from the Trenton group of Minnesota (I 7245), very like *L. sarlei*, shows distinct overlapping with very slight or no alternation.

The mutual relationships of *Lepidocoleus*, *Turrilepas*, and *Plumulites* are still obscure, and the Swedish fossils throw no further light on them. We have indeed still much to learn as to the mere structure of these skeletons before we can so much as say what relations they bore to the rest of the animal. Up to the present the main reason for referring them to the Cirripedia seems to be the difficulty of placing them anywhere else.

On the last page Professor Moberg figures two markings in the Black Trinucleus Shales of Ullnäs, which he believes to represent plates of a Cystid, one of the Rhombifera. His figure 1 certainly supports that interpretation. Since, however, Professor Moberg paid me the compliment of submitting these specimens for my opinion, I am entitled to say that the specimen itself is by no means of such regular appearance, and that neither it nor the original of fig. 2 are accepted by me as echinodermal. My own interpretation, given while still ignorant of the fact that *Plumulites* occurred in these beds, was that fig. 1 might represent one or more kite-shaped plates of that genus. Professor Moberg, however, rejects that interpretation with as much decision as I reject his. And so the matter rests.

F. A. Bather.

VIII.—British Carboniferous *Producti*.

Memoirs of the Geological Survey of England and Wales. Palæontology, vol. i, pt. iv. The British Carboniferous *Producti*. I. Genera *Pustula* and *Overtonia*. By Ivor Thomas, D.Sc., Ph.D. 4to; pp. 168, with 4 plates. London: Dulau & Co., 1914. Price 6*s*.

THE recent great revival of interest in the fauna of the Carboniferous, due to the researches of Vaughan, Sibly, Dixon, and others, has impressed on the author of the present work the necessity for a careful revision of the *Producti*, which form one of the most important groups of fossils in the Carboniferous rocks.

It has been found necessary to give a more detailed differentiation of forms than that which appeared satisfactory to Davidson and de Koninck, and consequently a number of new names have been introduced. The genus *Productus*, which appears to be certainly polyphyletic, has been subdivided into several genera, and the author has endeavoured to restrict the limits of the species and genera in order that these fossils may be used with greater accuracy and precision by both palæontologist and zonal stratigrapher.

In the present memoir only the pustulose and fimbriate forms are described, as the author is most unfortunately unable to complete the work he had undertaken. The introductory sections have, however, been written with a view to the ultimate description of all the British species. One of these sections is devoted to the history of the genus; this is followed by a discussion of the terminology. The terms adopted are in agreement, as closely as possible, with those already generally accepted. Much attention is paid to morphological characters, such as the development and functions of spines, the presence of ribs and costæ, the general shape of the shell, its internal features and shell structure.

Nomenclature and evolution are discussed at some length, though not so fully as had been the author's original intention. The important literature dealing with orthogenesis, homœomorphy, and other problems of evolution is reviewed in a most interesting manner, and copious references are given.

In the section dealing with classification it is proposed to restrict the name *Productus* to that group which contains the original *Anomites productus* of Martin, and to separate the *Producti*, mainly according to the nature of their ornamentation, into the following sections, to each of which is given a distinct generic designation.

Productus, J. Sow. Forms which are costate throughout all stages of growth. Genotype, *Anomites productus*, Martin.

Avonia, gen. nov. Forms which are spinose in the early stages but develop costæ at a later period. Genotype, *Productus youngianus*, Dav.

Pustula, gen. nov. Forms which are essentially spinose in ornamentation. Genotype, *Producta pustulosa*, Phill.

Buxtonia, gen. nov. Forms in which the young and adult stages are characterized by a costate and spinose ornamentation, while in old age spinosity alone is developed. Genotype, *Anomites scabriculus*, Martin.

Overtonia, gen. nov. This genus is founded upon internal peculiarities of the brachial valve, the importance of which is discussed in the definition. Genotype, *Producta fimbriata*, J. de C. Sow.

Proboscidella, Oehlert. Genotype, *Productus proboscideus*, de Verneuil.

Etheridgina, Oehlert. Genotype, *Productus complectens*, R. Etheridge, jun.

The genus *Daviesiella*, Waagen, is not ranked with the above generic divisions, as it is regarded as being more nearly related to the *Chonetes* series.

There are descriptions of twenty-three species of *Pustula*, of which twelve are new, and one species of *Overtonia*.

The work concludes with a comprehensive bibliography and index.

IX.—The Upper Cretaceous and Eocene Floras of South Carolina and Georgia. By E. W. Berry. United States Geological Survey, Professional Paper 84, pp. 200, pls. xxix, 1914.

THE most extensive of the new floras here described is that found in Turonian beds of South Carolina, over seventy species being recognized. Nearly a fifth of these are conifers, and about two-thirds dicotyledons. The facies may be compared with that of the Greenland Cretaceous flora, but there are several cosmopolitan types, and, as in many related floras, there is a mingling of forms such as the willow and walnut with others like the fig, *Eucalyptus* and *Araucaria* which are now climatically separated. The vegetation probably resembled most nearly the 'temperate rain-forests' of to-day, such as those of Southern Japan and New Zealand.

Since the upper Cretaceous deposits of Georgia are marine the plant fossils are fewer than in Carolina, only the most resistant leaves being preserved. Hence speculations on the character of the flora are of little value, but the author thinks that a mild damp climate prevailed.

Some useful maps are given of the past and present distribution of *Cinnamomum*, *Eucalyptus*, and other forms, showing clearly how cosmopolitan Cretaceous types have now become restricted and isolated.

Turning to the middle Eocene plants of Georgia, of which every species is described as new, we find a tropical littoral habitat indicated by several genera which the author has definitely recognized, including a mangrove (*Rhizophora*), which does not now extend so far north.

Many of the figures leave much to be desired, and often represent very fragmentary specimens, even in the case of some of the numerous new species. Regarding the family and generic identification of these leaves, the author himself admits that there is sometimes an element of doubt, and in one extreme case a new species (*Momisia americana*), referred to a genus which "has not previously been recorded in a fossil state", is described from a single incomplete leaf, which, moreover, closely resembles the common genus *Cinnamomum*.

The great difficulties met with in studying fossil angiosperms perhaps accounts for their neglect in England, on which the author comments as follows:—

"The splendid series of plant-bearing horizons of the south of England have, with the exception of sporadic descriptions of certain local florules by De la Harpe, Heer, Ettingshausen, and others, and the work of J. Starkie Gardner on the ferns and conifers, remained unknown down to the present. It seems remarkable that only two Englishmen, Bowerbank and Gardner, have devoted any considerable attention to these floras, and the latter failed to complete his work, so that in many ways the most interesting part of the British Eocene flora, certainly the most useful for purposes of correlation, remains unknown to science except for various antiquated and scattered references."

X.—Resins in Paleozoic Plants and in Coals of High Rank. By David White. United States Geological Survey, Professional Paper 85E, pp. 65–96, pls. ix–xiv, 1914.

THE importance of resins in the formation of Palæozoic coals is shown to be as great as in later periods. The abundance of resinous spores in Carboniferous times is well known, and in petrified material we see that many Carboniferous plants were provided with secretory canals and cells, the residues in which often suggest resins. Certain carbonized fragments of petioles and wood from the Coal-measures of Montana were found to contain abundant needle-like rods, which from their characters and mode of occurrence seem to represent the resinous fillings of longitudinal canals. Minute refractive bodies in coal have been described by Mr. James Lomax and others as resins, while in coal from the upper Mississippi valley the author discovered small lumps of resin which had persisted almost unaltered. The author suggests that though the amount of exuded resin in early times may have been small, it was abundantly stored in canals. That resins have not been more frequently recognized is due to the fact that they have been altered and carbonized, and in this connexion the author describes the resins in various Cretaceous and Tertiary coals, which have been found in all stages of alteration consequent on the change of the coal itself from peats and lignites to the bituminous types.

XI.—The Soils of Russia.

Die Typen der Bodenbildung, ihre Klassifikation und Geographische Verbreitung, von Professor Dr. K. Glinka, Direktor des landwirtsch. Instituts des Kaisers Peter I zu Woronesh. pp. 365, with 65 text-figures and a coloured map. Berlin (Borntraeger), 1914. Price 17*s*.

IT has long been known to workers in agricultural geology that a great amount of most valuable work in soil-investigation is being carried on in Russia. Occasionally portions of this have been made accessible to Western readers, such as the well-known papers of Sibirzev, communicated to the Geological Congress at Petrograd, and some most valuable memoirs submitted to the Agro-geological Congresses at Budapest and Stockholm. But in the case of the greater part of this work publication in the Russian language is an insuperable bar to its wider appreciation. Now, however, it has happily occurred to Professor Glinka to issue a German translation of his Russian lectures, illustrated by many figures and an admirable soil-map of the Russian Empire.

Briefly stated, the general thesis of the Russian soil-investigators is as follows: that the determining factor controlling the character of the soil is climate; under given climatic conditions similar soils can be formed from a great variety of different rocks. This is specially noticeable in the case of the well-known Tchernosem or black earth of Russia, a soil which maintains its fertility without manure for an indefinite time.

The soils of Russia may be divided into zones or belts, which, on the whole, show a close parallelism to the climatic belts, running

in a general north-east and south-west direction. In European Russia the zones generally recognized are, beginning in the south-east, the salt-steppes, the dry steppes, the Tchernosem, which may be compared to the prairies of America, the grey and bleached forest soils (podsol zone), and finally the frozen tundras of the far north. Besides these certain minor transitional forms are also recognized. None of the Russian soils appear to be quite similar to the normal meadow soils and 'brown earths' of Western Europe and Eastern America.

In the book before us a full account is given of the origin and characters of each of the principal soil-types of the Russian Empire, the whole subject being treated mainly on a climatic basis. The classification adopted is chiefly founded on the work of Sibirzev and Dokutchaiev, and the book forms a most valuable résumé of recent work of great importance, hitherto inaccessible; it should be carefully studied by all soil-workers in spite of the unnecessarily high price.

R. H. R.

XII.—Coast Sand Dunes, Sand Spits, and Sand Wastes. By Gerald O. Case. pp. xii + 162. London: St. Bride's Press, 1914. Price 5*s.* net.

THE object of this little book is to direct attention to the waste and devastation produced by the inland movement of sand dunes, and to show the beneficial results which follow when inblown sand is allowed to accumulate under human guidance, and fixed by artificial means so as to provide a permanent protection rather than a continual menace to the coast. Sand dunes may be fixed in three ways: (1) by planting a belt of suitable grasses and shrubs just above high-water line; (2) by building an embankment of earth or sand; and (3) by constructing a row, or series of rows, of openwork fencing. In these ways the formation of barren wastes by the inland drifting of sand is prevented, a line of defence against coast erosion is maintained, and it becomes possible to reclaim sand wastes already existing and convert them into pine woods, which are not only more beautiful, but which become, in the course of time, an important commercial asset.

Mr. Case deals adequately with these phases of his subject, not only from the engineering point of view but also from a geological standpoint. A large number of examples are cited, drawn from localities in all parts of the world, a feature which gives the book a special value as a work of reference, but which necessarily detracts from its quality as a readable work. The matter is, however, soundly treated throughout, and can be confidently accepted as an authoritative statement of a subject of extreme economic importance. It should prove to be of great value to coast engineers and local authorities who have to deal with the problem of moving sands. The book is well illustrated with numerous photographs and line drawings. The price appears to be somewhat excessive, and we would suggest that in a later edition the index, which is incomplete in its present form, should be considerably amplified, especially in regard to local place-names.

XIII.—The Volcanoes and Rocks of Pantelleria. By Henry S. Washington. Journal of Geology, vol. xxi, No. 7, p. 653, No. 8, p. 683, 1913; vol. xxii, No. 1, p. 16, 1914.

THE island of Pantelleria[1] lies midway between Sicily and Tunis, and with the exception of some local beds of travertine the exposed rocks which enter into its architecture are wholly volcanic. It is probable that a basement of plutonic rocks underlies the volcanic superstructure, for fragments of granite have been found in the lavas of Pantelleria, and xenoliths of diorite in the lava of Linosa, a small volcanic island which lies to the south-east. Pantelleria has become classic through the researches of Foerstner, who discovered there a remarkable series of lavas containing soda microcline and cossyrite. In 1905 a re-examination of the island was undertaken by Dr. Washington, and the present paper is the outcome of his studies in the field and subsequently in the laboratory.

The volcanic history of the island appears to have been as follows:—

Phase 1.—The building up of a large cone on a granite basement by successive flows of—

(1) Pantelleritic trachyte . . 66·85 SiO_2.
(2) Comendite . . . . 72·21 SiO_2.
(3) Ægirite or green pantellerite . 71·15 SiO_2.

This phase was ended by the formation of a caldera with its surrounding *somma*, owing either to explosion or to subsidence.

Phase 2.—The building up of a cone within the caldera by flows of—

(4) Soda trachyte . . . . 63·46 SiO_2.
(5) Pantelleritic pumice . . . 67·32 SiO_2.

Dislocation of part of the cone then took place, tilting up the south and depressing the north. Through the fractures so produced an eruption then took place of—

(6) Black pantellerite . . . 69·08 SiO_2.

Phase 3.—At the north-western end of the island eruptions of—

(7) Basalt . . . . . 46·09 SiO_2

then broke through. A submarine eruption in 1891 near the north-western coast marks the last sign of eruptive activity. Fumaroles (hot steam and sulphur dioxide) and hot springs (rich in soda) are now found in various parts of the island.

An excellent map of the island showing the distribution of the chief varieties of lava is given. Petrographic descriptions follow the general summary of events, and this part of the paper is enriched by seventeen analyses. In the succession of lavas as stated above, the average silica percentage of each member is appended, and it becomes clear that the rocks are sharply divided into two main groups, and that the order of succession agrees well with that enunciated by von Richtofen and Iddings, especially as regards the extreme character of the final product. The acidic lavas are remarkable for the consistent absence of nepheline and soda-lime plagioclase. All the felspars are alkalic, averaging $Or_1\ Ab_1$. The remaining soda is to be found in ægirite and cossyrite, and the excess of silica has crystallized as

[1] Note that the main accent is on the *i*, not on the second *e*.

quartz. Titanium, and to a less extent phosphorus, are remarkably abundant, and this feature becomes especially noteworthy in the basalts. It seems to be possible to correlate the presence of cossyrite with the high content of titanium, and the absence of riebeckite with the absence of fluorine and the low proportion of zirconium.

ARTHUR HOLMES.

XIV.—GEOLOGICAL EXCURSIONS ROUND LONDON. By GEORGE MACDONALD DAVIES, B.Sc., F.G.S. pp. 156, with maps, sections, and photographs. Thomas Murby & Co., 1914. Price 3*s.* 6*d.* net.

THIS is a useful little handbook and guide to the geology of some of the most interesting localities in the neighbourhood of London. The book is intended primarily for the use of students who require to gain some knowledge of field geology and who should be able to learn a great deal by following out these carefully planned excursions. It will also, no doubt, appeal to the many who are really interested in the geology of the London district, but are often unable to find their way to important sections or instructive view-points.

The first thirty-four pages are devoted to an outline of the stratigraphical geology of the South-East of England, the arrangement of which is clear and concise.

Twenty-six excursions are planned, fifteen of which are arranged as half-day excursions. Particulars of railway routes and fares are given, and with the very full directions it should be possible to follow out the itinerary without the aid of a map. Teachers should find this book of value in conducting field classes.

XV.—BRIEF NOTICES.

1. ARGYLLSHIRE AND BUTESHIRE. By PETER MACNAIR, F.G.S. pp. x + 161. Cambridge University Press, 1914. 1*s.* 6*d.* net.

The excellence of the Cambridge County Geographies has now been universally recognized, and in this member of the series, one of the latest to be issued, the high standard is easily maintained. The author has in Argyllshire a county which is extraordinarily difficult to describe from the geological and structural point of view in a space so short as that at his disposal. In Buteshire his task is less formidable, but in both cases he has succeeded in writing an admirable account of geological history, and of the surface features, scenery, and economic conditions which are its natural outcome. The book gives a well-balanced and thoroughly interesting account of two fascinating counties which provide holiday centres that are not easily surpassed.

2. NOTES ON RADIUM-BEARING MINERALS. By WYATT MALCOLM. Prospector's Handbook No. 1. Issued by the Geological Survey of Canada, 1914. pp. 26.

In this handy little book the uranium minerals—pitchblende, carnotite, autunite, and torbernite—and the modes of testing their radio-activity by the electroscope, the scintilloscope, and their effect on a photographic plate (the last, as the author warns, resulting also from

thorium minerals) are considered, and descriptions given of the more important localities in Portugal, Colorado, Utah, Cornwall, and Bohemia where the ores are commercially worked. The Canadian occurrences are more fully dealt with, and some useful hints are given to help the prospector in his search.

3. Geology of the Pitchblende Ores of Colorado. By Edson S. Bastin. United States Geological Survey, Professional Paper 90, A, 1914. pp. 5.

After a preliminary account of the principal pitchblende-producing localities the occurrence in the Quartz Hill District, Colorado, is considered. From a study of a polished section it appears that pitchblende crystallized contemporaneously with chalcopyrite, pyrite, and probably grey quartz. The predominant rocks are pre-Cambrian igneous and sedimentary rocks and Tertiary intrusive rocks. A lead-zinc mineralization followed closely a pyrite one, and pitchblende was deposited during the latter and afterwards fractured, the fractures being filled by sulphides of later mineralization.

4. Cretaceous Exogyras.—Professional Paper 81, Department of the Interior, United States Geological Survey, 1914, is devoted to the description and illustration of Cretaceous Exogyræ from the Eastern Gulf region and the Carolinas by L. W. Stephenson. They are a remarkably beautiful series of shells, being highly ornamented and unlike anything we have in this country. A general description of the deposits, and a map, prefaces the descriptions.

5. The Jurassic Flora of Cape Lisburne, Alaska. By F. H. Knowlton. United States Geological Survey, Professional Paper 85D, pp. 39–55, pls. v–viii, 1914.

The Corwin formation of Northern Alaska, containing much workable coal, has yielded several fossil plants, which show that the beds belong to the upper part of the Middle Jurassic. The flora is most closely related to that of Eastern Siberia, and of the seventeen species found in the Cape Lisburne region eight occur also in Amurland. The general facies is that of Jurassic floras almost all over the world, and this extraordinarily wide distribution leads the author to consider the possible means of dispersal of Jurassic plants. He concludes that there must have been "a practically continuous land connection between the several localities during Jurassic time", since only the ferns, with their light spores, could have crossed any considerable stretch of water.

6. Kalgoorlie, Western Australia.—Part i of the *Geology and Ore Deposits of Kalgoorlie* was issued in 1912 by Messrs. Simpson and Gibson, and we have lately received the second part by Messrs. Feldtmann & Farquharson,[1] together with the maps of the area. This district is now completed, and its rocks petrographically described. The publications are issued by the Geological Survey of Western Australia, Bulletins 42 and 51, at 5*s*. the two.

[1] An article, by R. A. Farquharson, F.G.S., on the "Petrology of a portion of the North Kalgoorlie Field" (Western Australia), appeared in the Geological Magazine for March, pp. 107–14, and April, pp. 148–57, 1914, Pls. V–VII.

REPORTS AND PROCEEDINGS.

I.—The Royal Society.

November 5, 1914.

1. "On Acquired Radio-Activity." By Sir William Crookes, O.M., LL.D., D.Sc., Pres. R.S.

Various objects, diamond, ruby, garnet, quartz, gold, platinum, etc., also the phosphorescent substances yttria, calcium sulphide, zinc blende, and barium platinocyanide, are bombarded in a high vacuum by cathode rays, and in no case can any permanent activity be recognized either by photographic or electrical means.

Exposure to radium emanation confers temporary radio-activity on all bodies that have been tried, apparently due to the condensation of the emanation on the surface. This transient activity can be completely removed by washing in dilute acids.

Many substances become coloured by direct exposure to radium, the colour depending on the substance. Diamond takes a full sage-green tint, the depth of tint depending on the time of exposure to the radium.

In addition to change of colour diamond also becomes persistently radio-active, continuously giving off α-, β-, and γ-rays. The acquired colour and activity withstand the action of powerful chemical agents, and continue for years with apparently undiminished activity.

Removing the surface by mechanical means removes both colour and radio-activity.

The appearance of an auto-radiograph made by placing an active diamond crystal on a sensitive photographic plate, and the visual examination of its 'scintillation' luminosity, suggest that there is a special discharge of energy from the corners and points of the crystal.

---

2. Medals for Research.

The King has approved of the following awards this year by the President and Council of the Royal Society:—

A Royal Medal to Professor Ernest W. Brown, F.R.S., for his investigations in astronomy, chiefly in the Lunar Theory.

A Royal Medal to Professor William J. Sollas, F.R.S., for his researches in palæontology, especially in the development of new methods.

The following awards have also been made by the President and Council:—

The Copley Medal to Sir Joseph Thomson, O.M., F.R.S., for his discoveries in physical science.

The Rumford Medal to Lord Rayleigh, O.M., F.R.S., for his numerous researches in optics.

The Davy Medal to Professor William Jackson Pope, F.R.S., for researches on sterochemistry and on the relations between crystalline form and chemical constitution.

The Darwin Medal to Professor Edward B. Poulton, F.R.S., for his researches in heredity.

The Hughes Medal to Professor John S. Townsend, F.R.S., for his researches on electric behaviour of gases.

II.—Geological Society of London.

November 4, 1914.—Dr. A. Smith Woodward, F.R.S., President, in the Chair.

The President announced that, at a meeting of the Council held that afternoon, it was decided to allow all Belgian geologists to enjoy the privileges of the Society during their enforced residence in our country. The Officers would be glad of the co-operation of the Fellows in bringing the names of such Belgian geologists to their notice.

The following communications were read:—

1. "The Inferior Oolite and Contiguous Deposits of the Doulting–Milborne Port District (Somerset)." By Linsdall Richardson, F.R.S.E., F.G.S.

In this paper a detailed description is given of the Inferior Oolite and contiguous deposits in the country between the Bath–Doulting and Sherborne districts. It embraces the country around Bruton, Castle Cary, and Blackford.

In the northern half of the Doulting–Milborne Port district the bulk of the yellow Upper Lias Sands is of *dispansi* hemera; but in the neighbourhood of Cole and Castle Cary the very topmost portion is of *dumortieriæ* hemera. In the south-eastern portion, under Stowell, while the main mass is probably of *moorei–dumortieriæ* hemeræ, the upper 50 feet or more is certainly of *aalensis–moorei* date.

Throughout the greater portion of the district the Inferior Oolite is, without doubt, non-sequentially related to the Upper Lias Sands.

Rock of *garantianæ* hemera spreads over the whole district, and is everywhere non-sequentially related to the beds below. From Doulting to the neighbourhood of Bruton the *Garantiana* beds rest directly on the Sands. In the neighbourhood of Cole, however, there is a synclinal area, and beds of *blagdeni*, *sauzei*, *witchelliæ*, *shirburniæ*, *discitæ*, and *murchisonæ* hemera are seen between the *Garantiana* beds and the Sands. The lower portion of the *Discites* bed at Strutter's Hill, Cole, is precisely identical, both as regards faunal and lithic characters, with the celebrated 'Fossil Bed' of Bradford Abbas.

None of these deposits seen in the neighbourhood of Cole is met with again until the neighbourhood of Corton Downs is reached. An anticlinal axis runs through the middle of the intervening tract, and is along a well-marked line of weakness.

At Corton Downs are rocks of *sauzei*, *witchelliæ*, *shirburniæ*, *discitæ*, *bradfordensis*, and *murchisonæ* hemeræ—that of the first hemera being identical with the "marl with green [glauconite] grains" at the well-known Milborne–Wick section. In this southern portion of the district, as is the case also around Cole, it is very difficult to determine the upper and lower limits of the deposits of *discitæ*, *shirburniæ*, and *witchelliæ* hemeræ. They comprise grey sandy limestones with sandy and marly partings—the whole of very uniform aspect and frequently rich in glauconite grains.

The rock of *garantianæ* hemera varies much from place to place in thickness and lithic structure. Near the Mendip Hills it is a conglomerate bed; in the country around Batcombe, ragstone very similar to the Upper *Trigonia* Grit of the Cotteswolds; at Strutter's

Hill, in part an *Astarte obliqua* bed—precisely similar to that at Halfway House and Burton Bradstock; at Hadspen, mainly a massively bedded brown building-stone (locally called 'Hadspen Stone'), full of fossils. Similar rock is seen at Shotwell and Woolston; but south of Blackford the *Garantiana* beds coalesce, as it were, with the superincumbent representative of the Doulting Stone, etc., and, while the lower part eventually passes into the Sherborne Building-stone, the upper portion (together with the equivalents of higher beds) becomes rubbly, associated with clayey matter, and passes into the Rubbly Limestone beds of the Sherborne district.

Above the *Garantiana* beds come, near the Mendips, the massive Doulting Stone, *Anabacia* limestones, and Rubbly Beds. The *Anabacia* limestones soon lose their distinctive lithic characters; but the Doulting Stone spreads over the whole of the Oolitic tract between Doulting, Bruton, and Cole, and is exposed in numerous quarries.

South of Blackford, as already remarked, the equivalent of the Hadspen Stone (*garantianæ*) is not easy to separate from the equivalent of the Doulting Stone, etc. In the southern portion of the district, the lower portion of the equivalent of the Hadspen Stone passes into the Sherborne Building-stone, and the top portion, *plus* higher beds, into the Rubbly Limestone beds such as those that are so well displayed in numerous quarries in the eastern portion of the Sherborne district.

Samples of the soft layers and of the marly matter from the interstices of the more rubbly beds have been examined by Mr. Charles Upton for micro-organisms; but they have proved singularly deficient in such organisms.

2. "Some Inferior Oolite Pectens." By E. Talbot Paris, B.Sc., F.C.S., and Linsdall Richardson, F.R.S.E., F.G.S.

During the course of one of the present authors' (L. R.) fieldwork in connexion with the unravelling of the detailed stratigraphy of the Inferior Oolite of the district between Stonesfield, in Oxfordshire, and Burton Bradstock, in Dorset—which is now completed—a large number of specimens of Lamellibranchs were found. Some of the *Gervilliæ* and *Pernæ* have already been dealt with (Proc. Cotteswold Nat. F.C., vol. xvii, pp. 233–5 and pl. xi, and pp. 237–54 and pls. xxviii–xxix, 1911). The present paper deals with the species of Pectinidæ that have been found during the investigations above mentioned.

Descriptions and illustrations are given of one new species of *Camptonectes*, of two new varieties of *Chlamys articulata* (auctt.), and of two new species of *Velopecten*.

November 18, 1914.—Dr. A. Smith Woodward, F.R.S., President, in the Chair.

The following communications were read:—

1. "On a Raised Beach on the Southern Coast of Jersey." By Andrew Dunlop, M.D., F.G.S.

Last June Mr. E. F. Guiton drew attention to a raised beach recently exposed on the southern coast of the island. It is on the

eastern slope of the ridge between Le Hocq and Pontac, and the section, facing northwards, shows the following succession of beds from above downwards:—

	Thickness in feet	*inches.*
1. Earthy loam, with a layer of rubble	4	0
2. Stiff brownish-red clay	1	0
3. Yellow loamy clay, containing water-worn pebbles and angular fragments	3	4
4. Coarse brown sand	3	6
5. Water-worn pebbles, closely packed in a matrix of coarse brown sand	4	6

The rock beneath is fine red granite. The section is terminated at its western end by sloping rock, and there, between the rock and the lower beds, is a layer of stiff brownish-yellow clay about 2 feet thick, which is continued for a short distance under the bed of pebbles.

The base of the section is about 50 feet above mean sea-level.

The pebbles in both the upper and the lower beds are mostly of the fine red granite of the locality, but there are some of diabase and of quartzite, as well as a few of flint. Flint is, of course, foreign to the island, but there are many flint pebbles on the recent beaches, especially on the north-eastern coast. Flint pebbles have also been found in at least two low-level raised beaches, and flint pebbles and fragments have been noticed in the yellow clay. Pebbles and fragments of Devonian shale have also been found in what appears to be a remaining fragment of a raised beach on the south-western coast.

Colonel Warton recently pointed out a raised beach, not previously noticed, in the railway cutting near the Eastern Railway station. This is also on the south side of the island, not far from the coast.

Its base is about 55 feet above mean sea-level, and it is covered by a thick bed of yellow loamy clay.

2. "On Tachylyte Veins and Assimilation Phenomena in the Granite of Parijs (Orange Free State)." By Professor S. James Shand, D.Sc., F.G.S., Stellenbosch, South Africa.

The district described is the neighbourhood of Parijs Township, which is situated on the Vaal River and lies upon the northern portion of the Vredefort granite-mass.

The so-called 'granite' near Parijs is a red and grey streaky gneiss, often traversed, both parallel to and across the foliation, by veins of red pegmatite; these are of a later period of consolidation than the rest of the rock. The author concludes from field-evidence that the grey facies of the gneiss results from assimilation of the country rock by an ascending magma, while the red facies represents the residual portion of the same magma.

The special interest of the district, however, lies not so much in the granite as in a system of tachylytic veins which everywhere intersects the granitic rocks. These veins range from a fraction of an inch to 2 feet in thickness, but in the thicker veins there are numerous inclusions of the country rock. They are irregular in form, thickness, and direction, and are due to the intrusion of a basic magma which underlay the district. The author describes the microscopic characters of these tachylytes, and comments on their

general glassy and cryptocrystalline nature, which he does not regard as a result of chilling, but suspects is dependent upon the viscosity of the basic magma.

He brings forward evidence to prove that the position occupied by the tachylyte is independent of tectonic features, but follows directly from solution and corrosion of the granitic rocks by the basic magma.

III.—Mineralogical Society.

Anniversary Meeting, *November* 10.—Dr. A. E. H. Tutton, F.R.S., President, in the Chair.

Professor W. J. Lewis: Albite; its Crystal Elements, etc. New values of the elements were obtained based upon measurements made on well-developed twinned crystals from Alp Rischuna. Chemical analysis showed them to be very pure albite.—H. Collingridge: The Determination of the Maximum Extinction Angle, Optic Axial Angle, and Birefringence of Monoclinic Pyroxenes in Thin Sections. The method depends on the presence of well-defined twins about 100, and the visibility of an optic axis through one individual. From observations in this individual of the positions of the trace of the optic axial plane and the twin plane, the extinction angle, and the position of the visible optic axis, and in the other the extinction angle and the birefringence, and, if possible, the positions of an optic axis and the trace of the optic axial plane, the requisite determinations may be made.—Professor H. L. Bowman: Note on Calcite from the Chalk at Corfe Castle, Dorset. Good crystals, which occur in veins in the Upper Chalk, are of the pointed habit, the forms being f $(11\bar{1})$ and x $(21\bar{2})$. Interpenetrant rhombohedra twinned about the c axis as in cinnabar are not uncommon.—A. Scott: Barkevikite from Lugar, Ayrshire, and Litharge from Persia. The former occurs in lugarite in prismatic crystals up to 75 mm. in length with mean refractivity 1·690 and very intense pleochroism, c very dark brown, b reddish-brown, a light yellow; in chemical composition it is fairly close to the type mineral from Barkevik. The latter was found at Larshuran, Persia, as a red mica-like crystalline mass; it is biaxial with mean refractivity 1·735, the double refraction being very weak, and contains over 97 per cent of lead oxide, the remainder being copper oxide with a little antimony oxide.—Dr. G. T. Prior: The Meteorites of Uwet, Kota Kota, and Angela; the identity of Angela and La Primitiva. The meteoric iron of Uwet, Southern Nigeria, said by natives to have fallen about ninety years ago, is a hexahedrite of the Braunau type, containing about 6 per cent of nickel. The meteoric stone of Kota Kota, Marimba District, British Central Africa, said by natives to have been seen to fall some years ago, is a chondrite, probably belonging to the crystalline spherulitic group. The meteoritic iron of Angela, near Iquique, Chili, was found in the nitrate beds. It is an ataxite, containing about 4·5 per cent of nickel and enclosing large nodules of schreibersite, and is probably identical with La Primitiva.

The following Officers and Members of Council were elected: President, Dr. A. E. H. Tutton, F.R.S.; Vice-Presidents, Professor

H. L. Bowman, Dr. A. Hutchinson; Treasurer, Sir William P. Beale, Bart., K.C., M.P.; General Secretary, Dr. G. T. Prior, F.R.S.; Foreign Secretary, Professor W. W. Watts, F.R.S.; Editor of the Journal, Mr. L. J. Spencer; Ordinary Members of Council, Mr. F. H. Butler, Mr. J. P. de Castro, Mr. B. Kitto, Professor A. Liversidge, F.R.S., Dr. J. J. Harris Teall, F.R.S., Mr. F. N. Ashcroft, Professor H. Hilton, Mr. A. Russell, Mr. W. Campbell Smith, Dr. J. W. Evans, Dr. F. H. Hatch, Mr. J. A. Howe.

IV.—Liverpool Geological Society.

The second meeting of the Session was held at the Royal Institution, Colquitt Street, Liverpool, on Tuesday, November 10, 1914, W. A. Whitehead, Esq., B.Sc., President, in the chair. A collection of specimens of Triassic sandstone was exhibited from the recent excavations in Brownlow Hill, and ably described by Miss S. E. Morton. Mr. C. H. Cox, B.Sc., Head Master of Upholland Grammar School, read a paper upon "Ordnance Survey Maps, their Meaning and Use", illustrated by a well-selected series of maps comprising the Highlands of Scotland, the English Lake District, West Cheshire, and the North Downs. Messrs. A. Harris and T. A. Jones exhibited a series of lantern slides of natural scenery in illustration of some of the points described in Mr. Cox's address. A cordial vote of thanks was accorded to Mr. Cox for his interesting paper.

V.—Zoological Society of London.

October 27, 1914.—Professor E. A. Minchin, M.A., F.R.S., Vice-President, in the Chair.

Mr. T. H. Withers, F.G.S., described a new Cirripede based on a number of disconnected valves from the Chalk of Hertfordshire. Except for three valves referred to a new species of *Scalpellum* (*sensu lato*), the whole of the material belongs to a remarkable new asymmetrical Cirripede which differs from *Verruca* in the more primitive structure of the valves, in the presence of two lower lateral valves on the rostro-carinal side, and in the absence of interlocking ribs. This species undoubtedly represents the ancestral type from which has arisen the recent group of asymmetrical sessile Cirripedes forming the family Verrucidæ, and in its structure clearly shows its origin from the symmetrical pedunculate Cirripedes of the family Pollicipedidæ. It presents further evidence that the sessile condition was arrived at independently on several different lines of descent during the evolution of the Cirripedia.

OBITUARY.

WILLIAM HILL, V.P.G.S.

Born August 2, 1849. Died November 8, 1914.

The death of William Hill, on November 8, 1914, came as a shock to many of his friends, who had little idea that his cheery countenance hid a mind liable to fits of depression. Born at Hitchin,

August 2, 1849, he was educated at Denmark Hill Grammar School, and appears to have entered at an early age into the public life of his native town. He held positions on the Board of Guardians, Local Board, Urban District Council, Hospital Board, Savings Bank, Corn Exchange, Burial Board, etc., and was created County Magistrate in 1895. On all these positions he brought to bear his geological knowledge, greatly to the advantage of his fellow-townsmen.

Mr. Hill was a Vice-President of the Geological Society of London, President of the Geologists' Association (1911–12), and had done a large amount of original work of value in the Cretaceous rocks. But the great geological work of his life was his unselfish devotion to his crippled friend Jukes-Browne. For years Hill spent week after week in the field, noting and surveying county after county and forwarding all the observations to his friend, who wrote them up for the Geological Survey memoir called *The Cretaceous Rocks of Britain*. Further results of this work were his brilliant addresses as President of the Geologists' Association on "Flint and Chert" and "Rocks containing Radiolaria", papers demanding not merely knowledge but technical skill and patience. William Hill died at Hitchin, November 8, 1914, and was buried there.

HENRY JAMES JOHNSTON-LAVIS, F.G.S., Etc.

Born July 19, 1856. Died August 10, 1914.

Dr. Johnston-Lavis was born in London, July 19, 1856. On the close of his primary education at a private school he sought to enter on the medical course at the University of Montpellier. That institution, however, having had to be closed on account of a revolt of the students, he attended instead at the University of Marseilles, where he studied for a year. At the beginning of the session 1873–4 he transferred to University College, Gower Street, London, and also studied some subjects at St. Mary's Hospital, Paddington. At the former institution he was placed in the First Class in Practical Chemistry in 1874, and in the First Class in Clinical Medicine in 1878. While there, also, he came under the teaching of Professor John Morris, then at his zenith, for Geology. This subject strongly attracted him and he joined the Geologists' Association in 1874, and was elected a Fellow of the Geological Society in 1875, having been by an oversight admitted before the full age. His first paper, "On the Triassic Strata which are exposed in the cliff sections near Sidmouth," was read before that Society in the following year. The bones he discovered at that locality proved to be new, and were described at the same time by Professor H. G. Seeley under the name of *Labyrinthodon Lavisii*. In 1876, also, he conducted evening classes in Physiology at the old Polytechnic in Regent Street. For several years he made a careful study of the Lower London Tertiaries exposed at Charlton and at Lewisham, which resulted in a paper attempting a correlation of the two sections, read before the Geologists' Association in 1877.

After obtaining his M.R.C.S.Eng. and L.S.A. in 1878 he married Mlle. Antonia Françoise Bourdariat de Saint-Aupre, whose acquaintance he had formed when at Marseilles, and who, he testifies in the dedication to his last published work, "through a long married life encouraged me in my medical and scientific work, affording me valuable help and appreciation and aiding me to overcome almost insurmountable difficulties."

Having spent some time in 1879 as an assistant to a doctor in Plaistow, and after taking the degree of B.ès Sci. Paris, he went out at the end of the year to Naples. There he practised among the members of the English and American colonies and the visitors, and became Sanitary Director to Sir W. Armstrong's works at Puzzuoli. In 1884 he took the degree of M.D. Naples. His attention when there was early directed to the part played by Edible Mollusca in the dissemination of infectious diseases, a subject to which he recurred later. Above all it was at Naples that he was started on his vulcanological studies. To the young, energetic, and ardent geologist Vesuvius, with its many fascinating problems, was a powerful loadstone, and consequently all his spare time was devoted to its study and survey.

His first important memoir on the subject was laid before the Geological Society in 1884. The paper was a long one and the author not then an acknowledged authority on the subject, so some condensation was insisted on before publication. Unfortunately, in his absence from England this was not too wisely or sympathetically done, and the omission of some portions spoilt the continuity of the work, a fact which involved the author subsequently in much useless discussion. The views embodied in the memoir have, however, been widely accepted on the Continent by competent authorities.

Numerous other papers on subjects connected with Vesuvius and the southern Italian volcanoes flowed from his pen during the succeeding years, including a study of, and monograph on, the great earthquake at Ischia, but his chief and perhaps most important work was the completion under great difficulties of his survey of Vesuvius during 1880–8, and publication in 1891 of the Geological Map in six sheets on the scale of 1 : 10,000. Save for the addition of some lava streams during the eruption of 1906 there is but little to alter in the map to-day.

He became a member of the Società Geologica Italiana in 1889, and during the autumn of that year the Geologists' Association paid a visit to the southern Italian volcanoes, mainly at the instigation of Dr. Lavis, on whom fell the brunt of the conduct of the party.

In 1890 Lavis visited Iceland in company with Dr. Tempest Anderson, and his observations there were published in a paper read before the Scottish (now Royal Scottish) Geographical Society in 1895. Mention may here be also made to the joint paper with Dr. J. W. Gregory on "Eozoonal Structure of the Ejected Blocks of Monte Somma", printed in 1894, in which the authors gave the *coup de grâce* to 'Eozoon'. He was appointed Professor (Pareg.) of Vulcanology in the Royal University of Naples in 1893, but never delivered any lectures.

In 1892 Lavis took up a consultative practice at Harrogate for the summer season and continued this annually till 1897. Quitting Naples in 1894, he practised for one season at Monte Carlo, and then made Beaulieu his headquarters for winter seasons and permanent place of residence. In order to qualify for the exercise of his profession in France he had to go through the medical course again, and he took his M.D. at Lyons in 1895, his thesis being a complete résumé of the part played by Edible Mollusca in the propagation of gastro-intestinal diseases.

His activities, however, were by no means confined to the immediate surroundings of Beaulieu, and he took a leading part in the foundation, mainly by the financial aid of Sir John Blundell Maple, of the Queen Victoria Memorial Hospital at Nice, of which he was senior Consulting Physician.

Becoming the English Consulting Physician to the celebrated Établissement at Vittel (Vosges), France, about 1904, he continued his summer practice there till the present year. On the outbreak of the War he dismissed his patients and started on August 1 to join his invalid wife near Château Thierry (Aisne), thence went on to Paris, and finally journeyed south, intending to reach Beaulieu by a circuitous and safe route. Unfortunately the whole journey from the very start from Vittel was attended by misadventures, which culminated on August 10 in the overset of the motor-car in which they were travelling, near Bourges (Cher). The rest of the party escaped with a shaking, but Lavis himself was pinned beneath the car and killed apparently instantaneously.

Although endowed with seemingly inexhaustible energy, it was still wonderful how much he accomplished without relaxing for a moment the scrupulous and unwearied attention he devoted to his very numerous patients. More than 160 books, memoirs, etc., including many important medical theses and articles, in addition to numerous vulcanological writings, stand to his credit; whilst his latest important memoir was *On the effects of Volcanic Action in the production of Epidemic Diseases in the Animal and Vegetable Creation*, etc. (1914), which gained the Parkin Prize of £100 triennially offered by the Royal College of Physicians of Edinburgh.

A man of wide interests, practical ever, rather than what is known as scholarly, he numbered amongst his other pursuits a wide acquaintanceship with ecclesiastical architecture, and the carved woodwork in the little English Protestant church at Vittel was executed by local workmen from his exceedingly tasteful and in some respects unique designs.

Never a moment seemed wasted by him. The odd minutes were devoted to looking after the fittings and furnishing of his laboratory or of his museum, in examining and cataloguing new accessions to his vulcanological library, or in framing after a method of his own some one or other of the valuable engravings he had acquired relating to his favourite subject.

His loss will be greatly deplored not only by his bereaved family, but also by a very wide circle of friends.

INDEX.

ABENDANON, E. C., Folds of Earth's Surface, 369.
Acids and Intermediate Intrusions, Roxburghshire, 233.
African Elephant, Origin of, 93.
Alaska, Geology of, 31 ; Flora, 567.
Algæ and Fungi Catalogue, British Museum, 228.
Allantopora stomatoporoides, gen. et sp. nov., W. D. Lang, 436.
American Palæontology, 125.
Anderson, Dr. Tempest, Bequest to York Philosophical Society, etc., 96.
Andrée, K., Mountain Formation, 369.
Andrews, E. C., Post-Jurassic Geography, 520.
Anthropoid Ape Jaw, Spain, 285.
Antiquity of Man in Europe, 553.
Aphralysia carbonaria, gen. et sp. nov., Garwood, 268.
Arber, Newell, Kent Coal-fields, 43, 527.
Argyllshire and Bute, 566.
Arid Lands, Physiography of, 421.
Aroha, Hauraki, New Zealand, Geology of, 329.
Arthropleura Moyseyi, n.sp., W. T. Calman, 541.
Asteroidea, British Palæozoic, 227.
Atlin District, British Columbia, 129.
Austin Brook, Iron in, New Brunswick, 233.
Australian Fossils, 230.
—— Marine Kainozoic Deposits, 516.
—— Tertiaries, 526.

BAGNALL, R. S., *Stenurothrips succineus*, gen. et sp. nov., 484.
Bailey, E. B., The Sgùrr of Eigg, 296 ; Ballachulish Fold, Argyllshire, 378.
Balearic Islands, Ossiferous Deposits of, 337.
Ball, Sir R. S., Obituary of, 46.
Barlow, A. E., Obituary of, 336.
Bate, D. M. A., *Testudo gymnesicus*, sp. nov., 100 ; Tortoise from Pleistocene, Menorca, 100 ; Ossiferous Deposits, Balearic Islands, 337.
Bather, F. A., Studies in Edrioasteroidea, 115, 162, 193 ; *Steganoblastus ottawaensis*, 193.
'*Batrachioides* the Antiquor,' Lockport Dolomite, 158.
Beaufort Beds, S. Africa, Zones of, 203.
Bell, J. M., Wilds of Maoriland, 554.
Bibliography of N. American Geology, 430.
—— North England, 36.
Bill, Ph. C., Crustaceans from Upper Bunter, Alsace, 325.
Bolton, H., Giant Dragon-fly, Radstock Coal-measures, 180.
Boring at Heathfield, Devon, 2, 16.
—— at Marston, Devizes, 445.
—— through Chalk, Denmark, 171.
British Association, Australia, 1911, 411, 457.
—— President's Address (Section C), 411, 457.
—— List of Geological Papers, 513.
British Glacialists, Conference of, 243.
—— Graptolites, 226.
Brydone, R. M., *Cribrilina cicatricifera*, sp. nov., 97 ; *C. vulnerata*, sp. nov., 97 ; *Homalostega marginula*, sp. nov., 98 ; *H. nitescens*, sp. nov., 98 ; *H. antecedens*, sp. nov., 99 ; *Membranipora simulacrum*, sp. nov., 345 ; *M. boletiformis*, sp. nov., 346 ; *M. suffragista*, sp. nov., 346 ; *M. cuculligera*, sp. nov., 481 ; *M. vestigialis*, sp. nov., 481 ; *M. præcipua*, sp. nov., 482 ; *M. sacerdotalis*, sp. nov., 482 ; *Mollia laminaria*, sp. nov., 98 ; New Chalk Polyzoa, 97, 345, 481 ; *Offaster pilula*, Zone of, 359, 405, 449, 509.
Bunter Pebble-beds, English Midlands, 211.
Burchard, E. F., Red Iron Ores, E. Tennessee, 230.

CALMAN, W. T., *Arthropleura Moyseyi*, n.sp., 541.
Cambridge County Geographies (Merionethshire), 176 ; (Argyllshire and Buteshire) 566.
Canada, Department of Mines, 375, 525.
—— Guidebook to Geology of, 427.
—— Victoria Museum, 88.
Cantrill, T. C., Coal-mining, 525.
Carboniferous *Producti*, British, 560.

Carlisle–Solway Basin, Structure of, 286, 287.
Case, G. O., Sand Dunes and Sand Wastes, 564.
Catalogue of Scientific Papers, Royal Society, 426.
Caucasus, Geological Map of, 371.
Cenomanian Chalk Cirripede, 494.
Chalk, Denmark, Deep Boring, 171.
—— Polyzoa, 97, 345, 481.
—— of Suffolk, 377.
—— Zone of *Offaster pilula* in, 359, 405, 449, 509.
Chapman, F., Australian Fossils, 230; Sequence Australian Tertiaries, 514.
Cheilostome Polyzoa, Cretaceous, 436.
Cheirotherium Footprints, 395.
Chiltern Wind-gaps, 145.
Cirripede from the Chalk Marl, Cambridge, 494; Herts, 573; Sweden, 558.
'Cleat' in Coal-seams, 49.
Climates and Physical Conditions, Pre-Cambrian, 466.
Coal Resources of the World, 22.
Coal-field, Kent, 527.
—— of Grand Mesa and West Elk Mountains, 29.
—— of India, 36.
—— Pennsylvania, 523.
Coal-measures, Plant Cuticles, 385.
—— Derbyshire, *Arthropleura*, 541.
Coal-mining, 525.
Coal-seams, 'Cleat' in, 49.
Cocchi, Prof. I., Obituary of, 47.
Cole, G. A. J., Mineralogy, 130; Wexford Gravels, 498.
Coleman, A. P., Climate in Pre-Cambrian, 466.
Collecting Specimens, Hints on, 178, 232.
—— Geological Specimens, 232.
Cordierite in Granite, Dartmoor, 67.
Cotteswold Naturalists' Field Club, 328.
Cretaceous Asteroidea, Evolution of, 28.
—— Cheilostome Polyzoa, *Herpetopora*, 5.
—— Exogyras, 567.
—— Flora, 562.
—— Flora, Catalogue British Museum, 228.
—— Plant, Nigeria, 433.
Cribrilina cicatricifera, sp. nov., Brydone, 97.
—— *vulnerata*, sp. nov., Brydone, 97.
Crookes, Sir W., Radio-activity, 568.
Crust of the Earth, 377.
Crustacean Fauna, Upper Bunter, Alsace, 325.
Cryptogams, Fossil, 229.

DACRYOPORA gutta, gen. et sp. nov., W. D. Lang, 442; *D. Reussi*, gen. et sp. nov., W. D. Lang, 443.
Daly, R. A., Igneous Rocks and their Origin, 473.
Dartmoor Granite, Cordierite in, 67.
David, T. W. E., Permo-Carboniferous, 468.
Davies, G. M., Geology round London, 566.
Day, A. L., Water and Volcanic Activity, 231.
Debenham, F., Sedimentary Rocks, South Victoria Land, 467.
Deeley, R. M., Ice-flows in Trent Basin, 69; Freezing of Surface Soil, 95.
Denudation of Arid Regions by Wind and Water, 424.
Desert Erosion, 18, 73.
Deserts (Definition, Causes, and Soils), 419.
Devonian Fossils, Torquay, 311.
—— System of Maryland, 89.
Diamonds in British Columbia, 375.
Dietrich, W., Origin of African Elephant, 93.
Dinantian and Avonian, Correlation of, 234.
Distribution of Plants in tracing Geological Boundaries, 8.
Douvillé's Lamellibranchia, 476.
Dragon-fly in Radstock Coal-measures, 180.
Dreikanter Formation, South Notts, 208.
Dresser, J. A., Serpentine Rocks, S. Quebec, 558.
Dryopithecus, Mandible of, 285.
Dun, W. S., Correlation of Permo-Carboniferous, 468.
Dunlop, A., Raised Beach, Jersey, 570.
Dunn, S. C., Hints on Collecting Geological Specimens, 178.
D'Urban, Artesian Well-boring, British Guiana, 282.

EARTH Folds and Mountain Formation, 369.
Earthquakes and Infra-Plutonic Shell, 65.
East Anglia, Prehistoric Society, 34.
Economic Geology, 427.
Edinburgh Geological Society, 239.
Edrioasteroidea, 115, 162, 193.

Egyptian Echinoderms, 477.
Eigg, Sgùrr of, 296, 306.
Elles & Wood, British Graptolites, 226.
Eoanthropus, Note on, 44.
Eolithic Controversy, 546.
Evans, J. W., Collecting Geological Specimens, 232.
Evolution of Essex River System, 283.

FABER, H., Deep Boring in Chalk, Denmark, 171.
Fannich Mountains, Loch Maree, etc., Geology, 85.
Fareham and Havant, Geology of, 278.
Farquharson, R. A., Petrology of N. Kalgoorlie, 107, 148.
Ferguson, D., Geology of South Georgia, 53.
Fermor, L. Leigh, Isostasy, Earthquakes, and Vulcanicity, 65.
Ferrar, H. T., Nature and Origin of Fiords, 189; Loess Deposits, Egypt, 421; Permo-Carboniferous Breccia, 465.
Fertility of Soil, 34.
Fifty Years of GEOLOGICAL MAGAZINE, 241.
Fisher, Rev. O., Obituary of, 383.
Flora, Cretaceous and Eocene, 562.
Florida Coral-reef Tracts, 329.
Foraminifera, 135.
—— of Speeton Clay, Yorkshire, 216, 255, 289.
Fossil Cryptogams, 229.
—— Insect in Amber, 483.
—— Man, 553.
—— Track of Dying Lobster, 480.
Fourtau, R., Egyptian Echinoderms, 477.
Freezing of Surface Soil, 95.

GANOID Fishes, British Carboniferous, 227.
Gardiner, C. I., Silurian Rocks, Co. Galway, 135.
Garwood, E. J., Rock-building Organisms, Lower Carboniferous, 265; *Ortonella furcata*, gen. et sp. nov., 266; *Aphralysia carbonaria*, gen. et sp. nov., 269.
Geikie, J., Mountains, their Origin, Growth, and Decay, 26; Antiquity of Man in Europe, 553.
Genetic Relations of Gypsum and Anhydrite, 271.
GEOLOGICAL MAGAZINE Fifty Years Old, 241.
Geological Society, Edinburgh, 239.
—— London, 37, 43, 44, 94, 135, 137, 179, 181, 233, 235, 236, 283, 285, 330, 333, 378, 379; Library, Recent Additions, 376.
Geological Society, Liverpool, 377.
Geological Survey, Alabama, 430.
—— Canada, 88, 129, 233; Memoirs, 375.
—— England, Memoirs, 278, 373, 375, 475.
—— India, Memoirs, 127.
—— Maryland, 89.
—— Portugal, 429.
—— Scotland, Memoirs, 85, 276.
—— United States, 430.
—— Wisconsin, 93.
Geology of Alaska, U.S., 31, 430.
—— South Georgia, 53.
Georgia, South, Rocks of, 59.
Gibson, A. H., Natural Sources of Energy, 33.
Glinka, K., Soils of Russia, 563.
Gordon, Dr. W. T., Appointment Geological Department, King's College, 48.
Grabham, G. W., Collecting Geological Specimens, 178; Geological Society's Abstracts, 431.
Gregory, J. W., Geological Relations, S. Georgia, 61; Chiltern Wind Gaps, 145; Evolution of Essex River System, 283; Structure of Carlisle–Solway Basin, 286, 287; Deserts (Definition, Causes, and Soils), 419; Australian Kainozoic Deposits, 516.
Grey Granite, Transvaal, 528.
Griffithides Shunnerensis, King, sp. nov., 392.
Guidebooks to Canada's Geology, 427.
Günther, A. C. L. G., Obituary of, 140.
Gypsum and Anhydrite in Genetic Relations, 271.

HALL, T. S., Victorian Graptolites, 468; Sequence of Victorian Tertiaries, 517.
Harker, A., The Sgùrr of Eigg, 306.
Harmer, F. W., Pliocene Mollusca, 227.
Harrison, J. B., Artesian Well Boring, British Guiana, 282.
Hatch, F. H., Petrology of Igneous Rocks, 177; New Classification of Ore-deposits, 223.
Hawkins, H. L., On the Holectypoida, 1.
Heathfield, Devon, Boring, 16.
Herman, H., Tertiary Coal-beds, Victoria, 466.
Herpetopora, gen. nov., Lang, 5; *H. anglica*, n.sp., Lang, 6; *H. clavigera*, n.sp., Lang, 6; *H. danica*, n.sp., Lang, 7.

Hickling, G., Triassic and Permian Rocks, Moray, 399.
Hill, Rev. E., Lifting by Ice-melting, 12.
Hill, W., Obituary of, 573.
Holectypoida, Problematical Structures in, 1.
Holland, Sir T. H., Presidential Address, Section C, British Association, 411, 457.
Holmes, A., Laterite Deposits, 529.
Homalostega antecedens, sp. nov., Brydone, 98; *H. marginula*, sp. nov., Brydone, 98; *H. nitescens*, sp. nov., Brydone, 98.
Horwood, A. R., Rock-soil and Plant Distribution, 8.
Hudson Bay Exploration, 428.
Huene, F., Saurischia and Ornithischia, 444.
Hume, W. F., Walther's Desert Erosion, 18, 73; Physiography of Arid Lands, 421.
Huntly (Aberdeenshire), Geology of, 137.
Hydrothermal Formation of Silicates, 132.

ICE-FLOWS in Trent Basin, 69.
Ice-melting as Transport Agent, 12.
Idaho, Geology of, 32.
Iddings, J. P., Igneous Rocks, 25, 473, 528.
Illing, V. C., Paradoxidian Fauna, Stockingford Shales, 379.
Inclusions in Whin Sill, Northumberland, 244.
Indo-China, 33.
Inferior Oolite, Somerset, 569.
—— Pectens, 570.
Infra-Plutonic Shell, Earth's, 65.
Interglacial Geology, 498.
Isopods, North German Mesozoic, 325.
Isostasy, Earthquakes, and Vulcanicity, 65.

JOHNSTON, J., Metamorphic Processes, 131.
Johnston-Lavis, H. J., Saturation of Minerals, 381.
—— Obituary of, 480.
Jones, W. R., Tin *in statu nascenti*, Malay, 537.
Judd, J. W., Geology of Rockall, 237.
Jukes-Browne, A. J., Heathfield Boring, 16; Devonian Fossils, Torquay, 311; Boring near Devizes, 445.
Jukes-Browne, A. J., Obituary of, 431.
Jurassic Flora, Cape Lisburne, Alaska, 567.

KALGOORLIE, N., Petrology of, 107, 148, 567.
Karroo, Zones of Beaufort Beds of, 203.
Kendall, P. F., 'Cleat' in Coal-seams, 49.
Kent Coal-field, Fossil Floras of, 43.
Kew, W. S. W., Tertiary Echinoids, Colorado, 281.
Kewagama Lake, Quebec, 555.
Kindle, E. M., '*Batrachioides* the Antiquor,' 158.
King, W. B. R., *Griffithides Shunnerensis*, sp. nov., 390, 392.

LAMELLIBRANCHES, Classification des, 476.
Lamplugh, G. W., Nottinghamshire Water Supply, 475.
Land Tortoise from Pleistocene, Menorca, 100.
Lang, W. D., *Allantopora stomatoporoides*, gen. et sp. nov., 436; Cretaceous Cheilostome Polyzoa, 436; *Dacryopora gutta*, gen. et sp. nov., 441; Geology of Lyme Regis and Charmouth, 554; *Herpetopora anglica*, gen. et sp. nov., 5, 6; *H. clavigera*, sp. nov., 6; *H. danica*, sp. nov., 7; *Marssonopora*, gen. nov., 438.
La Touche, T. H. D., Geology of N. Shan States, 127.
Laterite Deposits, Mozambique, 529.
Lavas, North Head, Otago Harbour, New Zealand, 333.
Lawson, A. C., Archæan Geology, 556.
Lifting by Ice-melting, 12.
Lindeman, E., Austin Brook Iron-bearing District, N. Brunswick, 233; Magnetite Occurrences, Ontario, 233.
Lithology, Durham, Magnesian Limestone, 179.
Lockport Dolomite, New York, *Batrachioides*, 158.
Loess Deposits, Egypt, 421.
London, Excursions round, 566.
Lyme Regis and Charmouth, Geology of, 554.

McMURTRIE, J., Obituary of, 192.
Macnair, P., Argyll and Bute, 566.
McRobert, R. W., Acids and Intermediate Intrusions, Roxburghshire, 234.

Magnetite Occurrences in Central Ontario, 233.
Mahony, D. J., Victoria in Kainozoic Period, 469.
Malay, Clays and Mesozoic Granite in, 309; Tin in Springs, 537.
Man, Antiquity of, 553.
Maoriland, Wilds of, 554.
Marshall, Professor P., Lavas at North Head, Otago, New Zealand, 333.
Marssonopora, gen. nov., W. D. Lang, 442.
Marston, Devizes, Boring at, 445.
Matley, C. A., Bunter, 211.
Medals, Royal, 568.
Membranipora boletiformis, sp. nov., Brydone, 346; *M. simulacrum*, sp. nov., Brydone, 345; *M. suffragista*, sp. nov., Brydone, 346.
Mennell, F. P., Cordierite in Dartmoor Granite, 67; Origin of Igneous Rocks, 528.
Menorca, Gigantic Land Tortoise from, 100.
Merionethshire, 176.
Mesozoic Granites and Clays, 309.
—— Plants, British Museum Catalogue, 228.
Metamorphic Processes, General Principles, 131.
Méthode Universelle de Fedoroff, 425.
Mineral Resources of Alaska, 430.
Mineralogical Society, London, 45, 188, 238, 380.
Mineralogy for Geological Students, 130.
Minerals, Saturation of, 319, 485.
Miocene Ostracoda, 179.
Moberg, J. C., Palæozoic Cirripedes, 558.
Mollia laminaria, sp. nov., Brydone, 98.
Mollusca, Life of, 78.
Moore, E. S., Coal-fields, Pennsylvania, 523.
Morayshire, Triassic and Permian Rocks of, 399.
Morey, G. W., Hydrothermal Formation of Silicates, 132.
Morris, A., Merionethshire, 176.
Mountains, their Origin, Growth, and Decay, 26.
Mozambique, Laterite Deposits of, 529.
Mud-lumps, 329.
Murray, Sir John, Obituary of, 191.

NATURAL Sources of Energy, 33.
Nature and Origin of Fiords, 189.
New York State, Geology of, 330.
New Zealand, Mines Department, Minerals of, 179; Wilds of Maoriland, 554.
Newton, R. B., Devonian Fossils, Torquay, 311.
Nicholas, T. C., Geology of St. Tudwal's, Carnarvon, 136; Trilobite Fauna, Middle Cambrian, Carnarvon, 380.
Nigeria, Cretaceous Plant from, 433.
Niggli, P., Equilibria of Silica and Alkali Carbonates, 132.
Nikitin, Méthode Universelle de Fedoroff, 425.
Nordingrå, Sweden, Geology of, 86.
Norfolk and Norwich Naturalists' Society, 35.
Nottingham, S., Dreikanter Formation of, 208.
Nottinghamshire Water Supply, 475.

OBITUARY Notices: Sir R. S. Ball, 46; A. E. Barlow, 335; Professor I. Cocchi, 47; Rev. O. Fisher, 383; Dr. A. C. L. G. Günther, 141; W. Hill, 573; H. J. Johnston-Lavis, 480; A. J. Jukes-Browne, 431; J. McMurtrie, 192; Sir J. Murray, 191; H. Potonié, 192; K. H. F. Rosenbusch, 140; G. Sharman, 240; Sir J. B. Stone, 344, 383; E. Suess, 288; Dr. A. Russel Wallace, 47: N. H. Winchell, 336; H. B. Woodward, 142.
Offaster pilula, S. English Chalk, 359, 405, 449, 509.
Ordovician and Silurian Rocks, Co. Galway, 135.
Ore-deposits, New Classification of, 223.
Ornithischia, Saurischia, 444.
Ortonella furcata, gen. et sp. nov., Garwood, 265.
Ossiferous Deposits, Balearic Islands, 337.
Oswald, F., Geological Map of the Caucasus, 371.

PALÆOLITHIC Engraving, Sherborne, 236.
—— Implements, Kansas, 35.
Palæontographical Society, vol. lxvii, 226.
Palæontology, Text-Book of, 84.
Palæozoic Cirripedes, Sweden, 558.
Paléontologie Végétale, 229.
Papposaurus Traquairi, gen. et sp. nov., Watson, 348.
Paradoxidian Fauna, Stockingford Shales, 379.

Paris, E. T., Inferior Oolite Pectens, 570.
Peach, B. N., Geology of Fannick Mountains, etc., 85; Geology of Ross-shire, 276.
Pebble-beds of Bunter, English Midlands, 211.
Pectens from Inferior Oolite, 570.
Pelourde, F., Fossil Cryptogams, 229.
Penny, F. W., Vredefort Granite and Witwatersrand System, 332.
Permo-Carboniferous Breccia, 465.
—— Correlation of, 468.
Petrography, Saturation in, 485.
Petrology of Igneous Rocks, 177.
—— North Kalgoorlie Field (West Australia), 107, 148.
Piltdown Man, Note on, 44.
Pisidia, British, 83.
Pitchblende Ores, Colorado, 567.
Plant Cuticles, Coal-measures, Britain, 385.
Pliocene Mollusca, Great Britain, 227.
Pliolophus vulpiceps, Type of, 480.
Polyzoa, Chalk, 97, 345, 436, 481.
Post-Jurassic Geography, Australia, 520.
Potonié, Henry, Obituary of, 192.
Pritchard, Sequence of Victorian Tertiaries, 519.
Problematical Structures in Holectypoida, 1.
Producti, Carboniferous, 560.

QUATERNARY Ice Age, 524.

RADIO-ACTIVITY, Crookes, Sir W., 568.
Radium-bearing Minerals, 566.
Rainy Lake, Archæan Geology, 556.
Raised Beach, Jersey, 570.
Ramsey Island, Pembrokeshire, Geology, 522.
Red Iron Ores, East Tennessee, 230.
Reed, F. R. C., Palæozoic Trilobites, Girvan, 227; Genus *Trinucleus*, 349; Sedgwick Museum Notes, 544.
Reptilian Type Femur, Lower Carboniferous, Scotland, 347.
Reynolds, S. H., Silurian Rocks, Co. Galway, 135.
Richardson, C. H., Economic Geology, 427; Inferior Oolite, Somerset, 569.
Robinson, H. H., Volcanic Field, Arizona, 479.
Rockall, Geology of, 237.
Rock-building Organisms, Lower Carboniferous, Westmorland, 265.
Rock-soil and Plant Distribution, 8, 139.
Rosenbusch, K. H. F., Obituary of 140.
Ross-shire, Central, Geology of, 276.
Royal Society, 378; Medals, 568.
Russell, E. J., Fertility of Soil, 34.

ST. TUDWAL'S Peninsula (Carnarvon), Geology of, 136.
Sand Dunes and Sand Wastes, 564.
Sandberg, C. G. S., Grey Granite, Transvaal, 528.
Saratoga Springs, 330.
Sargent, H. C., Rock-soil and Plant Distribution, 139.
Saturation in Petrography, 485.
—— of Minerals, 319, 381, 485.
—— and Genesis of Igneous Rocks, 381.
Saurischia and Ornithischia, 444.
Scalpellum parvulum, sp. nov., T. H. Withers, 494.
Scandinavian Drift of Durham Coast, 331.
Scott, A., Saturation of Minerals, 319.
Scrivenor, J. B., Topaz-bearing Rocks, Federated Malay States, 285; Malayan Clays and Mesozoic Granite, 309.
Sedgwick Museum Notes, 349, 544.
Sedimentary Rocks, S. Victoria Land, 467.
Seismological work of John Milne, 328.
Sequence Australian Tertiaries, 514.
Serials, New: Gravenhage (Holland), Padua, Brazil, Canada, 134.
Serpentine Rocks, South Quebec, 558.
Sgùrr of Eigg, 296, 306.
Shan States, Burmah, 127.
Shand, S. J., Saturation in Petrography, 485; Tachylyte Veins, Orange Free State, 571.
Sharman, G., Obituary of, 240.
Sherlock, R. L., Foraminifera of Speeton Clay, 216, 255; *Cristellaria chapmani*, sp. nov., 261; *Pulvinulina lamplughi*, sp. nov., 290.
Silica and Alkali Carbonates, Equilibria of, 132.
Skeats, E. W., Tertiary Alkali Rocks, Victoria, 470.
Smith, Professor G. Elliott, Brain of *Eoanthropus*, 94.
Smythe, J. A., Inclusions in Great Whin Sill, 244.
Sobral, J. M., Geology of Nordingrå, 86.

Soils of Russia, 563.
South Georgia, Geology of, 53, 59, 61.
Spath, L. F., Development of *Tragophylloceras loscombi*, 333.
Speeton Clay Foraminifera, 216, 255, 289.
Spencer, W. K., Cretaceous Asteroidea, 28; Deep Boring in Chalk, Denmark, 171; British Palæozoic Asteroidea, 227.
Spongites Saxonicus, 135.
Stanford's Geological Atlas, British Isles, 133.
Steganoblastus ottawaensis, 193.
Stenurothrips succineus, gen. et sp. nov., R. S. Bagnall, 483.
Stolley, E., Isopods from German Mesozoic, 325.
Stone, Sir J. B., Obituary of, 383.
Stopes, M. C., Mesozoic Plants, 228; Cretaceous Plant, Nigeria, 433; *Typhacites Kitsoni*, sp. nov., 435.
Strahan, Dr. A., Ramsey Island Geology, 522.
Strickland's Collection, 544.
Suess, Eduard, Obituary of, 288.
Summers, H. S., Victoria Alkali Rocks, 472.
Swinnerton, H. H., Dreikanter Formation, S. Notts, 208.

TACHYLYTE Veins, Orange Free State, 571.
Tertiary Alkali Rocks, Victoria, New South Wales, 470.
—— Brown Coal-beds, Victoria, 466.
—— Echinoids, Carrizo Creek, Colorado, 281.
Testudo gymnesicus, sp. nov., Bate, 100.
Thermal Springs, Tin in, 557.
Thomas, I., British Carboniferous *Producti*, 560.
Tin *in statu nascenti*, Malay, 537.
Topaz-bearing Rocks, Federated Malay States, 285.
Torquay, Devonian Fossils, 311.
Tragophylloceras loscombi, Development of, 333.
Traquair, R. H., Ganoid Fishes, British Carboniferous, 227.
Trenchmann, C. T., Composition of Durham Magnesian Limestone, 179; Scandinavian Drift, Durham Coast, 331.
Trent Basin, Ice-flows in, 69.
Trenton Limestone, Edrioasters of, 115, 162, 193.
Triassic Fauna of India, 329.
—— and Permian Rocks, Moray, 399.
Trilobite Fauna, Middle Cambrian, Carnarvon, 380.
—— from Millstone Grit, 390.
Trilobites of Girvan, Lower Palæozoic, 227.
Trinucleus, Notes on genus, 349.
Typhacites Kitsoni, n. sp., M.C. Stopes, 433.
Tyrrell, G. W., Rocks of South Georgia, 59.
Tyrrell, J. B., Hudson Bay Exploration, 428.

UNDERGROUND Waters, 134.
Université de Louvain, Mém. de l'Institut Géologique, 329.

VAUGHAN, A., Dinantian and Avonian, 234.
Victoria Graptolites, 468.
—— in Kainozoic Period, 469.
—— Kainozoic Alkali Rocks, 472.
—— Tertiaries, Sequence of, 517, 519.
Volcanic Cycles in Sardinia, 327.
—— Field, Arizona, 479.
Volcanoes of Pantelleria, 565.
Vredefort Granite and Witwatersrand System, 332.

WALLACE, Dr. A. Russel, Obituary of, 47.
Wallace, R. C., Gypsum and Anhydrite in Genetic Relations, 271.
Walther, J., Desert Erosion, 18, 73; Denudation of Arid Regions, 424.
Warren, S. H., Eolithic Controversy, 546.
Washington, H. S., Volcanic Cycles in Sardinia, 327; Volcanoes of Pantelleria, 565.
Water and Volcanic Activity, 231.
Water-supply Papers, 36.
Watson, D. M. S., Zones of Beaufort Beds, 203; Femur of Reptile, Lower Carboniferous, Scotland, 347; *Pappposaurus Traquairi*, gen. et sp. nov., 348; *Cheirotherium*, 395; Triassic and Permian Rocks, Moray, 399.
Watt, W. R., Geology of Huntly, Aberdeen, 137.
Wexford Gravels and Interglacial Geology, 498.

Whin Sill, Northumberland, 244.
White, H. J. O., Geology, Fareham and Havant, 278.
Willis, T. L., Coal-fields of Colorado, 29.
Wills, L., Plant Cuticles, Coal-measures, 385.
Wilson, M. E., Kewagama Lake, Quebec, 555.
Winchell, N. H., Obituary of, 336.
Wind Gaps, the Chiltern Hills, 145.
Wisconsin Geological and Natural History Survey, 93.
Withers, T. H., Cirripede, Cenomanian Chalk Marl, 494; *Scalpellum parvulum*, sp. nov., 496; Chalk, Herts, 573.
Woodward, A. S., Note on Piltdown Skull, 44; Palæolithic Drawing, 236; Lower Jaw of *Dryopithecus*, Spain, 285.
Woodward, B. B., Life of the Mollusca, 78; Catalogue of British Museum *Pisidia*, 83.
Woodward, H. B., Geological Atlas of British Isles, 133.
—— Obituary of, 142.
Wright, W. B., Quaternary Ice Age, 524.

YORKSHIRE Chalk Fossils, 35.
Yünnan, Western China, Geology of, 326.

ZITTEL, Karl A. von, Palæontology, American Edition, 84.
Zoological Record, 134.
—— Society, London, 46, 573.

ERRATUM.

ZONE OF *OFFASTER PILULA* (BY R. M. BRYDONE).

The table at p. 511 should read as follows :—

	A. granulatus.	Intermediate forms.	*A. quadratus.*
Chalk of zone of *A. quadratus* whose position can be fixed by reference to the zone of *O. pilula.*	Two in Sussex, 15 feet above zone of *O. pilula.*	—	One in Sussex, 8 feet above zone of *O. pilula.*
Subzone of abundant *O. pilula.*	—	—	Four in Hants. One in Sussex.
Upper part of subzone of *E. scutatus* var. *depressus.*	One in Sussex.	Three in Sussex.	One in Hants.

Note.—Two of the Sussex Belemnites have been found since the Sussex section of the paper went to press.

THE

GEOLOGICAL MAGAZINE

OR

Monthly Journal of Geology.

WITH WHICH IS INCORPORATED

THE GEOLOGIST.

EDITED BY

HENRY WOODWARD, LL.D., F.R.S., F.G.S., &c.

ASSISTED BY

PROFESSOR J. W. GREGORY, D.Sc., F.R.S., F.G.S.
DR. GEORGE J. HINDE, F.R.S., F.G.S.
SIR THOMAS H. HOLLAND, K.C.I.E., A.R.C.S., D.Sc., F.R.S., F.G.S.
DR. JOHN EDWARD MARR, M.A., Sc.D. (CAMB.), F.R.S., F.G.S.
DR. J. J. H. TEALL, M.A., Sc.D. (CAMB.), LL.D., F.R.S., F.G.S.
PROFESSOR W. W. WATTS, Sc.D., M.Sc., F.R.S., VICE-PRES. GEOL. SOC.
DR. ARTHUR SMITH WOODWARD, F.R.S., F.L.S., PRES. GEOL. SOC.

LIBRARY OF THE
UNIVERSITY OF WISCONSIN

DECEMBER, 1914.

CONTENTS.

I. ORIGINAL ARTICLES. *Page*

The Lateritic Deposits of Mozambique. By ARTHUR HOLMES, A.R.C.S., F.G.S. (Pl. XXXVII and two Text-figures.) 529
The supposed case of Tin in Springs. By W. R. JONES, B.Sc., F.G.S. 537
On *Arthropleura Moyseyi*, n.sp., from the Coal-measures, Derbyshire. By W. T. CALMAN, D.Sc. (Plate XXXVIII.) 541
Sedgwick Museum Notes. By F. R. COWPER REED, D.Sc., F.G.S. ... 544
Some Points in the Eolithic Controversy. By S. HAZZLEDINE WARREN, F.G.S. (With a Text-figure.) 546

II. REVIEWS.

Dr. James Geikie: The Antiquity of Man in Europe 553
W. D. Lang's Geology of Lyme Regis and Charmouth 554
Dr. Bell's Wilds of Maoriland ... 554
Kewagama Lake, Quebec 555
Archæan Geology, Rainy Lake ... 556
Serpentine Rocks of South Quebec 558
Professor Moberg: Palæozoic Cirripedes 558

REVIEWS (*continued*). *Page*

British Carboniferous *Producti* ... 560
Cretaceous and Eocene Floras ... 562
Resins in Fossil Plants 563
The Soils of Russia 563
Coast Sand Dunes, etc. 564
Volcanoes of Pantelleria 565
Geological Excursions round London 566
Brief Notices: Argyllshire and Bute — Radium-bearing Minerals — Pitchblende Ores, Colorado—Cretaceous Exogyras — Jurassic Flora, Alaska—Kalgoorlie ... 567

III. REPORTS AND PROCEEDINGS.

Royal Society—
November 5, 1914 568
Geological Society—
November 4, 1914 569
November 18 570
Mineralogical Society—
November 10, 1914 572
Liverpool Geological Society—
November 10, 1914 573
Zoological Society—
October 27, 1914 573

IV. OBITUARY.

William Hill, J.P., V.P.G.S. ... 573
Dr. H. J. Johnston-Lavis, F.G.S. ... 574

LONDON: DULAU & CO., LTD., 37 SOHO SQUARE, W.

☞ The Volume for 1914 of the GEOLOGICAL MAGAZINE is ready, price 26s. net. Cloth Cases for Binding may be had, price 1s. 6d. net.

With this Number is presented an Extra Sheet, containing Index, Title-page, etc., for Decade VI, Vol. I, 1914.

JUST PUBLISHED.

JAMES SWIFT & SON'S

NEW ILLUSTRATED CATALOGUE

OF

Petrological and Metallurgical MICROSCOPES

Measuring Instruments, and other Scientific Apparatus.

POST FREE ON REQUEST.

UNIVERSITY OPTICAL WORKS,

81 Tottenham Court Road, London, W.

PRICE 15s. NET. IN TWO SHEETS.

A GEOLOGICAL MAP OF THE CAUCASUS

(WITH EXPLANATORY TEXT).

Compiled from the latest sources by FELIX OSWALD, D.Sc., F.G.S.

Scale 1 : 1,000,000 (15·78 miles = 1 inch). The geological formations and the igneous rocks are clearly displayed in twenty different colours. The glaciers are also indicated. All heights are given in English feet, and the latest railways have been inserted. The pamphlet of explanatory text gives a brief account of the main physical divisions of the Caucasus, followed by a detailed description of the successive geological horizons with their characteristic fossils. Special care has been taken to indicate the exact position in the geological series at which petroleum occurs in the Caucasian oil-fields.

"It is produced in a bold style, somewhat like that of Noë's Map of the Alps, and embodies a good deal of personal study by the author. This work will be of service to many travellers, now that the district is so accessible through Constantinople or Odessa, and it will be of much help to readers of Suess's description of the range."—*Nature* (August 30, 1914).

DULAU & CO., Ltd., 37 Soho Square, London, W.

LIST OF BOOKS OFFERED FOR SALE

AT THE NET PRICES AFFIXED BY

DULAU & CO., LTD., 37 SOHO SQUARE, LONDON, W.

BEYSCHLAG (F.), VOGT (J. H. L.), AND KRUSCH (P.). The Deposits of the useful Minerals and Rocks, their Origin, Form, and Content. Translated by E. J. Truscott. London, 1914. (3 vols.) 8vo. Vol. i, with 291 illustrations. Cloth. 18*s*.

GEIKIE (A.). Outlines of Field Geology. 2nd edition. London, 1879. 12mo. pp. 222, with numerous illustrations. Cloth. (Pub. 3*s*. 6*d*.) 2*s*.

GUNTHER (C. G.). The Examination of Prospects, a Mining Geology. New York, 1912. 8vo. pp. 233. Illustrated. Leather. 8*s*. 6*d*.

HALDANE (J.). Les causes de mort dans les explosions de mines et les incendies souterrains. 1897. 8vo. Plate. 2*s*.

HARGER (J.). Coal, and the Prevention of Explosions and Fires in Mines. Newcastle-on-Tyne, 1913. Crown 8vo. Cloth. 3*s*. 6*d*.

HIND (H.). On the Mount Uniacke, Oldham, and Renfrew Gold Mining Districts. Halifax, 1872. 8vo. Plates. 2*s*.

HOBBS (W. H.). Simple Directions for the Determination of the common Minerals and Rocks. London, 1914. 8vo. pp. 31. Sewed. 1*s*.

HULL (E.). A Treatise on the Building and Ornamental Stones of Great Britain and Foreign Countries, arranged according to their geological distribution and mineral character. London, 1872. 8vo. pp. 333, with 2 plates. Cloth. (Pub. 12*s*.) 6*s*.

HUMBOLDT (A. v.), EHRENBERG (G.), UND ROSE (G.). Reise nach dem Ural, dem Altai, und dem Kaspischen Meere, auf Befehl Sr. Maj. des Kaisers von Russland im Jahre 1829 ausgeführt. Also under the title: Mineral. geognost. Reise nach dem Ural, dem Altai, und dem Kaspischen Meere, von G. Rose. Berlin, 1837–42. 2 vols. 8vo. With 10 plates and 5 maps (1 coloured, 4 partly coloured). 12*s*. 6*d*.

Vol. i: Reise nach dem nördlichen Ural, und dem Altai. Vol. ii: Südl. Ural, Kaspisches Meer, Übersicht der Mineral. und Gebirgsarten des Ural.

JAPAN. Catalogue of the Minerals, Rocks, Fossils, Shells, and Casts in the Geological Department of the Imperial College of Engineering. Tokio, 1880. 8vo. pp. 188. 2*s*.

JAPAN. Mining in Japan, Past and Present. (Bureau of Mines, Department of Agriculture and Commerce of Japan.) 1909. 8vo. pp. 322, with 3 plates and 3 maps (2 coloured). Cloth. 5*s*.

JAPON. Les Mines du Japon, rédigé par le Bureau des Mines, Ministère de l'Agriculture et du Commerce. Paris, 1900. 8vo. pp. 530, with coloured map, and 54 plates and plans. 8*s*.

Ouvrage publié par la Commission Impériale du Japon à l'occasion de l'Exposition Universelle de Paris, 1900.

JOHANNSEN (A.). A Key for the Determination of Rock-forming Minerals in Thin Sections. New York, 1908. 8vo. pp. 554, with 107 figures, 24 diagrams, and folding coloured plate. Cloth. £1 1*s*.

MARR (J. E.). The Scientific Study of Scenery. 4th edition. London, 1912. 8vo. pp. 372, with 23 plates and illustrations. Cloth. 5*s*.

PARRY (W. E.). Journal of a Second Voyage for the Discovery of a North-West Passage from the Atlantic to the Pacific: performed in the years 1821–3 in H.M.'s ships *Fury* and *Hecla*. London, 1824. 4to. pp. 571, with 9 maps and 29 plates. Half-calf. 11*s*. Fine crisp copy.

PIKE (MAJOR Z. M.). Voyage au Nouveau-Mexique, à la suite d'une expédition ordonnée par le gouvernement des États-Unis, pour reconnoître les sources des rivières Arkansas, Kansès, La Plate et Pierre-Jaune, dans l'intérieur de la Louisiane occidentale. Précédé d'une excursion aux sources du Mississippi, pendant les années 1805, 1806, et 1807. Traduit de l'Anglais par Breton. Paris, 1812. 2 vols. 8vo, with 3 maps. 9*s*.

WRIGHT (W. B.). The Quaternary Ice Age. London, 1914. 8vo. pp. 464, with 23 plates and maps and many illustrations. Cloth. Gilt. 17*s*.

JUST PUBLISHED. Crown 8vo. pp. 341. With 150 Illustrations and Map of Australia. 7s. 6d. net; by post 7s. 11d.

AUSTRALASIAN FOSSILS

A Students' Manual of Palaeontology.

By FREDERICK CHAPMAN,

Palaeontologist to the National Museum, Melbourne; formerly Assistant in the Geological Department of the Royal College of Science, London; Assoc. Linnean Soc. [I ond.], F.R.M.S., etc.; Author of "The Foraminifera", "A Monograph of the Silurian B alved Mollusca of Victoria", "New or Little-known Victorian Fossils in the National Museum", etc.

With an Introduction by Professor E. W. SKEATS, D.Sc., F.G.S.

GEOLOGICAL MAGAZINE.—The work cannot fail to be of great service, not only to students, but to all interested in geological studies on the other side of the globe.

Three Quarto Volumes of about 400 pages each, small 4to, and an Atlas of 66 pages of maps in colours, 13½ × 19½, bound in heavy paper cover. Price £5 5s. per set net.

THE COAL RESOURCES OF THE WORLD.

An Inquiry made upon the initiative of

THE EXECUTIVE COMMITTEE OF THE TWELFTH INTERNATIONAL GEOLOGICAL CONGRESS, CANADA, 1913,

with the assistance of

GEOLOGICAL SURVEYS AND MINING GEOLOGISTS OF DIFFERENT COUNTRIES.

EDITED BY THE

GEOLOGICAL SURVEY OF CANADA.

With numerous Plates and Illustrations in the Text, and accompanied by an Atlas of 66 pages of maps in colours.

"The preparation of the monograph involved a large amount of special investigation in several of the countries from which reports were submitted, and the three volumes with the atlas of beautifully executed maps will serve as a fitting companion volume to the iron resources of the world."—*Nature.*

A NEW AND ORIGINAL

GEOLOGICAL MAP OF ARMENIA

AND ITS BORDER-RANGES

with indications of Ores, Minerals, Mineral Springs, Analyses of Waters of Salt Lakes, and with the fullest and latest topographical details. It comprises new Surveys by the Author, and embodies all previous geological observations. All known heights are given in feet; the mountain ranges and volcanoes are clearly indicated. Scale: 16 miles = 1 inch. Size of sheet, 36 by 25 inches. Drawn and Hand-coloured in 20 Waterproof Tints

By FELIX OSWALD, D.Sc., B.A., F.G.S.,

Author of "A Treatise on the Geology of Armenia", 516 pages.

The Map is accompanied by a pamphlet of explanatory notes indicating the geological history of Armenia and the distribution and occurrence of the geological formations (with lists of fossils) and of the igneous rocks.

Price Twenty-one Shillings net.

Sole Agents for Great Britain :

DULAU & CO., Ltd., 37 Soho Square, London, W.

All Communications for this Magazine should be addressed to

THE EDITOR,

13 Arundel Gardens, Notting Hill, London, W.

Books and Specimens to be addressed to the Editor as usual, care of

MESSRS. DULAU & CO., LTD., 37 SOHO SQUARE, W.

STEPHEN AUSTIN AND SONS, LTD., PRINTERS, HERTFORD.